Orthographic representations in Dutch poor readers

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Voorwoord

Het voorwoord is de plaats om mensen te bedanken voor hun aandeel in dit promotieproject. Zoals iedereen weet, kan een dergelijk project niet uitgevoerd worden zonder de hulp van vele anderen. Ik wil hen daarvoor hartelijk bedanken. Op de eerste plaats wil ik Rob en Wim bedanken voor hun vertrouwen in mij en voor hun begeleiding bij de uitvoering van het onderzoek. Ludo werd pas in een latere fase bij het project betrokken. Ludo, bedankt voor je hulp bij het herstructureren van de tekst en voor al je motiverende woorden. Onmisbaar was natuurlijk ook de medewerking van de scholen en de inzet van de kinderen. De testassistenten zorgden ervoor dat alle lees- en spellingtoetsen binnen redelijke termijn afgerond konden worden. Tenslotte wil ik Walter bedanken, die mij in stress-situaties altijd een hart onder de riem stak en mij met raad en vooral daad bijstond.

Introduction **1**

Dutch orthography can be seen as fairly transparant (cf. Nunn, 2001), taking up an intermediate position between Finnish (highly transparent) in which there is a one-to-one correspondence between phonemes and graphemes and English (opaque) in which there is a high number of one-to-many and many-to-one correspondences. Initial reading instruction in The Netherlands involves teaching children to sound out the graphemes that constitute a written word, and combine these sounds into a spoken word. With practice, this process is internalised and automatised. Initial spelling instruction in The Netherlands involves teaching children to segment spoken words into their constituent speech sounds, and represent these sounds with the appropriate graphemes. A complicating factor, however, is that a number of speech sounds can be represented by two (or more) graphemes. For instance, the labio-dental fricative in word-initial position can be represented by 'f' and 'v', and the diphthong /ɛi/ can be represented by 'ij' and 'ei'. The word /fɛin/ can therefore be spelled in a number of phonologically correct ways, all of which have been observed in our spelling tests:

Joyce, 9;5 years	Tim, 9;7 years	Sabine, 8;10 years	Joris, 9;8 years
vijf	veif	fijf	feif

Educational practice in The Netherlands shows that the occurrence of such errors tends to prolong in developmental reading and spelling disordered children. This illustrates the necessity of storing high-quality orthographic representations. In this thesis, an attempt is made to arrive at a better understanding of the processes involved in the acquisition of such representations in normal and poor beginning readers of Dutch. Before going into the design of the research (section 1.3), I will present the theoretical background of the present thesis. In section 1.1, I will discuss dual-route theory as a general framework for the interpretation of reading and spelling processes. In section 1.2, I will go into the processes involved in learning to read and spell.

Modelling reading and spelling processes *1.1*

The central assumption of dual-route theories of reading is that two independent processes (routes) can be used to generate a word's pronunciation: a lexical process and a nonlexical process (see Figure 1.1). The lexical process operates by access to a word's representation in an orthographic input lexicon followed by retrieval of that word's spoken form from a phonological output lexicon. The nonlexical process operates by applying a set of grapheme-to-phoneme correspondence (GPC) rules to a string of letters and assembling its phonology (e.g., Coltheart, Curtis, Atkins, & Haller, 1993).

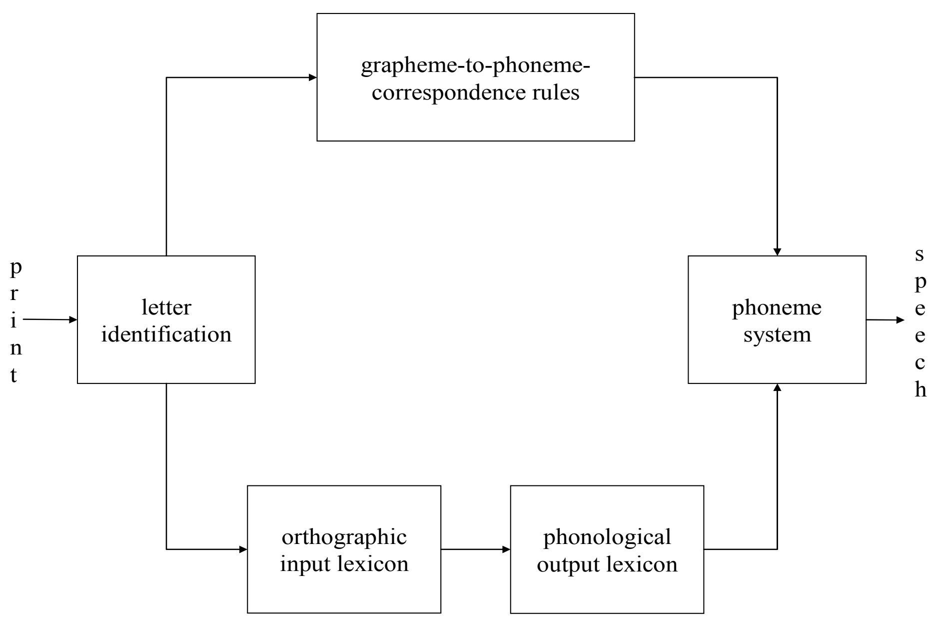


Figure 1.1 The dual-route model of reading aloud

According to Van Orden, Pennington, and Stone (1990) the independent-processes assumption is interwoven with three other hypotheses. The *GPC*-hypothesis assumes that there are unambiguous rules for mapping graphemes to phonemes. The *bypass* hypothesis assumes that beginning readers make nearly exclusive use of the nonlexical route but that this route is eventually bypassed as direct associations develop between orthographic codes and phonological codes. The *delayed-phonology* hypothesis assumes that the nonlexical route is relatively slow as compared to the lexical route. Paap, Noel, and Johansen (1992) pose that these are not intrinsic properties of dual-route theory. In fact, they acknowledge that “a viable rule-based system may require units of various grain sizes, rules of varying strength, and rules that generate conflicting phonological hypotheses.” (p. 295) Furthermore, they assume that the “routines [...] operate in parallel to generate both addressed phonology based on whole-word units and assembled phonology based on subword units.” (p. 293) And finally, they suggest that the speed of the lexical route is determined by word frequency and that the speed of the nonlexical (or phonological) route is determined by rule consistency, i.e. whether a grapheme maps onto a single phoneme or not. Whether or not the phonological route is slower than the lexical route depends on the word in question. Paap et al. conclude that the phonological route requires more time than the lexical route to generate a pronunciation for high-frequency words that draw on inconsistent rules, but that the phonological route requires less time than the lexical route to generate a pronunciation for low-frequency words that draw on consistent rules.

Dual-route theories of spelling are in many respects the mirror image of dual-route theories of reading. It is assumed that two routes can be used to generate a word’s spelling: a lexical route and a nonlexical route (e.g., Kreiner, 1992, 1996, Link & Caramazza, 1994, Snowling, 1994). The lexical route operates by access to a word’s representation in a phonological input lexicon followed by retrieval of that word’s graphemic representation from an orthographic output lexicon. The nonlexical route operates by segmenting a word into its constituent phonemes and applying a set of phoneme-to-grapheme correspondence (PGC) rules to the string of phonemes. Dual-route theorists now recognise that the nonlexical procedure is sensitive to the frequency of occurrence of phoneme-to-grapheme mappings in the language, to the consistency of these mappings, and may also be sensitive to context (for example, in Dutch /t/ is always represented by ‘t’ in word-initial or medial position, but it may be represented by either ‘t’ or ‘d’ in word-final position). They thus distance themselves from a strict *PGC*-hypothesis. The *bypass* hypothesis—assuming the gradual replacement of phonological processes by lexical processes—is also not generally accepted by dual-route adherents. Kreiner (1992, 1996) claims that both routes operate in parallel (cf. Paap et al., 1992). “If both routes are always invoked, it should sometimes be the case that spelling information for the same phoneme would be produced by both routes. If the two routes produced conflicting spellings, the speller would have to make a decision about which spelling to produce. [...] It is assumed for this parallel-interactive model of spelling that making this decision would require additional spelling time. The speller may simply choose the spelling for the phoneme that was produced first; that is, the fastest route would win and produce the spelling for the phoneme. When polygraphy is high, the phonological route should be slower than the lexical route, but the phonological route should be faster when polygraphy is low" (Kreiner, 1996, p. 51). Like Paap et al., Kreiner does not accept the *delayed-phonology* hypothesis as an intrinsic property of dual-route theory. What remains is the assumption that a lexical route and a nonlexical route can be used to generate a word's pronunciation or its spelling.

The frequency with which a word is used in the language is often found to influence reading speed and spelling accuracy. Dual-route adherents take this as an indication that the lexical route is used. For reading, it has traditionally been assumed that the process of *identifying* the orthographic pattern in the mental lexicon that best matches the input is a major locus of frequency effects. This assumption has been challenged by Balota and Chumbley (1985). They argue that a large part of the effect of frequency on naming latency must be attributed to processes occurring after lexical identification. This interpretation is based on their observation that the frequency effect in delayed naming—in which the subject's response is deferred until some time after the word has been identified—was a substantial portion of the effect found in immediate naming. Monsell, Doyle, and Haggard (1989) and Savage, Bradley, and Forster (1990) on the other hand found no effect of frequency on delayed naming. They conclude that word frequency does not affect articulatory processing, but they leave open the possibility that the retrieval of the phonological code associated with an identified orthographic pattern is a frequency-sensitive process. This is consistent with McCann and Besner's (1987) suggestion that at least some of the frequency effect in word naming resides in the connections between lexical entries in the orthographic input lexicon and lexical entries in the phonological output lexicon. McCann and Besner advance this view to explain the lack of a real word frequency effect in the naming of pseudohomophones. (By real word frequency is meant the frequency of the real word counterparts of the pseudohomophones. For example, the real word frequency of the pseudohomophone "wheal" is copied from the frequency of the word "wheel" in a given corpus.) Pseudohomophones were named faster than pseudowords that are not homophonic with real words, suggesting that lexical entries in the phonological lexicon have been accessed. However, pseudohomophones based on high-frequency words were not named faster than pseudohomophones based on low-frequency words. McCann and Besner conclude that the process of identifying the entry in the phonological lexicon that best matches the assembled phonological code (of a pseudohomophone) is not frequency sensitive. For reasons of architectural parsimony, they extend this conclusion to the process of identifying an entry in the orthographic lexicon and place at least some of the word-frequency effect in the connections between the entries in the various components of lexical memory.

McCann and Besner's (1987) line of argument crucially depends on two assumptions. The first is that base word frequency—i.e., the number of times the graphemic pattern occurs in a given corpus—is a valid measure of the frequency of occurrence of the phonological pattern. The second is that lexical identification processes are similar in the orthographic lexicon and the phonological lexicon. Neither assumption is beyond doubt. This undermines the conclusion that the process of identifying an entry in the lexicon is not frequency sensitive. The observation that the delayed naming of words is not affected by their frequency (Monsell et al., 1989, Savage et al., 1990) is also consistent with traditional accounts of the frequency effect that place it at the stage where a single lexical representation is isolated from the rest of the lexicon. I will adopt this position in my dissertation.

The process of lexical identification has been modelled in different ways. Coltheart et al. (1993) adopted McClelland and Rumelhart's interactive-activation model for the lexical route. "In the model, perception results from excitatory and inhibitory interactions of detectors for visual features, letters, and words. A visual input excites detectors for visual features in the display. These excite detectors for letters consistent with the active features. The letter detectors in turn excite detectors for consistent words. Active word detectors mutually inhibit each other" (McClelland & Rumelhart, 1981, p. 375). The baseline activation level of the detectors is determined by frequency of activation of the detector over the long term. Given the same amount of input, the detectors of high-frequency words reach threshold for unique identification more quickly than those of low-frequency words. Paap et al. (1992) adopted the activation-verification model for the lexical route (Paap, Newsome, McDonald, & Schvaneveldt, 1982).

No theoretical model has been proposed which specifies the locus of frequency effects in spelling accuracy. Word frequency may affect ease of retrieval of a word's graphemic representation from an orthographic output lexicon, but this will primarily be reflected in processing speed. The effect of frequency on spelling accuracy must probably be attributed to differences in representation quality. The orthographic representations of words that have rarely been seen may be less well specified than those of words that have been encountered frequently. Wherever they are located, word frequency effects are taken as an indication that the lexical route is used.

Learning to read and spell 1.2

In the present thesis dual-route theory will be taken as a frame of reference. However, dual-route theories generally do not account for reading and spelling aquisition nor for developmental disorders. For one thing, they do not explain how beginning readers acquire the GPC rules. Coltheart, Curtis, Atkins, and Haller (1993) developed an algorithm which learns the GPC rules embodied in the set of words on which it is trained. The algorithm aims at learning which letters or letter combinations correspond to single phonemes. If the number of letters in a word is equal to the number of phonemes, the algorithm infers rules by assuming a simple one-to-one mapping of letters to phonemes. If a word has more letters than phonemes (e.g., school with six letters and /sku:l/ with four phonemes), the algorithm uses the single-letter rules it has already learned to account for as many letter-phoneme pairs as possible. Whatever remains unaccounted for is used to form a multiletter rule. The psychological value of the algorithm is unclear.

Another lacuna in most versions of dual-route theory is that they do not explain how beginning readers acquire orthographic representations and how the orthographic representations become associated with the phonological representations of the words. The presumed independence of the two routes prohibits the output of the phonological route from being used in forming an association between the orthographic pattern and the phonological pattern of a word. Instead, these associations must be rote memorised. As Ehri (1992) correctly observes, “it is highly unlikely that these [systematic letter-sound] relations are ignored in favour of rote memory” (p. 112). She argues that readers form systematic connections between graphemes identified in the printed word and phonemes detected in the spoken word. The connections are based on readers’ general knowledge of grapheme-phoneme correspondences. For example, in learning to read *school*, readers recognise that *s* connects with /s/ and that *l* connects with /l/ in the pronunciation of the word. These connections are stored in lexical memory and are used in recognising the printed word. At first, only some of the graphemes are connected to phonemes in the word’s pronunciation (see Figure 1.2 A). As phonological decoding skill improves, readers establish connections between each grapheme and the phoneme it represents in the word. Also the sequence of graphemes is connected to the blend of phonemes (see Figure 1.2 C). These connections enable the reader to retrieve a word’s pronunciation without resorting to GPC rules.

Although not clearly expressed, Ehri (1992) assumes that the orthographic pattern, the phonological pattern, and the connections between them are stored as a whole. Readers form “connections between letters in spellings and phonemes in pronunciations and retain the spellings in memory as orthographic ‘images’ amalgamated to pronunciations” (p. 137). A hiatus in Ehri’s theory concerns the nature of orthographic (and phonological) representations at different developmental stages. We take the position that partially specified orthographic representations develop into fully specified representations, and that this development keeps pace with the establishment of connections between graphemes and phonemes (see Figure 1.2). In this view, quality of orthographic representations[1] relates directly to the number and strength of the connections.

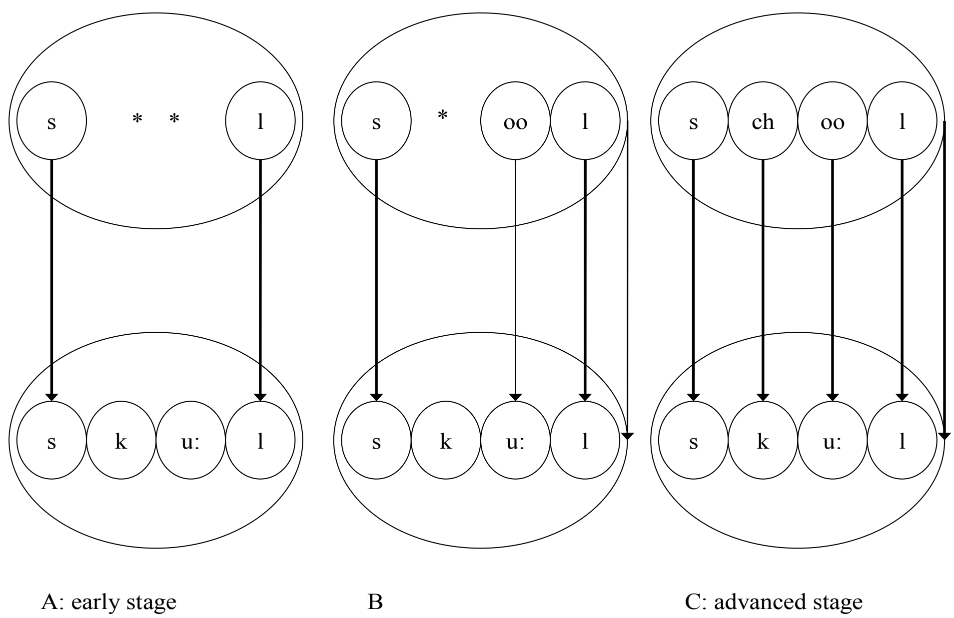


Figure 1.2 Orthographic representations (top row), phonological representations (bottom row), and the connections between them in an early stage of literacy acquisition and in more advanced stages

[1] According to Link and Caramazza (1994), orthographic representations specify more structure than just information about the identity and order of graphemes, inter alia, graphosyllabic structure, morphological structure, and the consonant-vowel status of graphemes. Furthermore, they argue that the sequential order of the component graphemes in the orthographic representation is represented spatially rather than ordinally.

Ehri's conceptualisation of the lexical route explains how the acquisition of orthographic representations builds on phonological decoding skill (i.e., the self-teaching mechanism, Share, 1995), but at the same time undermines the fundamental assumption of dual-route theory that there are two functionally independent routes. Nonetheless, Ehri adheres to the idea of two routes: a nonlexical, phonological route and a lexical route that is 'paved' with phonology. "The main difference involves the unit that is used to locate a specific word in the lexicon: a blend of phonemes versus a sequence of letters" (p. 120).

Snowling's (1994) conceptualisation of the process of spelling acquisition much resembles Ehri's (1992) ideas about reading acquisition. "There must exist procedures for identifying the particular letter strings within a word that represent particular phonemes. Once these have been abstracted, they will be stored to develop the lexical knowledge-base" (Snowling, p. 125). She proposes that the "mappings between orthography and phonology established during reading are used by the child to test hypotheses as to how these words are written. The hypotheses themselves are actively created by the child in the form of semiphonetic or phonetic spelling attempts. When a mismatch between their attempt and their stored knowledge is identified, future attempts at the word will be modified to reflect this newly acquired knowledge" (Snowling, p. 121).

Theories of literacy acquisition must also account for developmental reading and spelling disorders. It is generally acknowledged that the phonological processing skill of poor readers / spellers is impaired (e.g., Elbro, Nielsen, & Petersen, 1994, Gillon & Dodd, 1994, 1997, Masterson, Hazan, & Wijayatilake, 1995, McDougall, Hulme, Ellis, & Monk, 1994, Siegel, 1993, Wade-Woolley & Siegel, 1997). According to Ehri (1992), the acquisition of orthographic representations directly depends on phonological decoding skill and phonemic segmentation skill. It follows from Ehri's model that "the connections formed between letters in spellings and sounds in pronunciations are partial and incomplete, not only because poor readers lack knowledge of some letter-sound relations, but also because they are poor at segmenting pronunciations into constituent phonemes" (p. 139).

A relatively small amount of research has been done on poor readers' ability to store (high quality) orthographic representations and to use these representations for reading and spelling. In line with Ehri's prediction, a number of studies with English-speaking children suggest that poor readers have stored fewer, or less specified orthographic representations than normal readers, and that in poor readers the orthographic representations are weakly connected with the phonological representations (Alegria & Mousty, 1996, Ehri & Saltmarsh, 1995, Foorman, Francis, Fletcher, & Lynn, 1996, Landerl, Frith, & Wimmer, 1996, Stanovich & Siegel, 1994; see Chapter 3 for a detailed discussion of these studies). However, a number of studies in the English language area suggest that poor readers can compensate for their phonological processing deficit by the development of superior orthographic processing skill (Rack, 1985, Zecker, 1991, Holmes & Standish, 1996; see Chapter 3 for a detailed discussion of these studies). The English data therefore are not unequivocal.

Furthermore, it is important to examine the lexical reading and spelling skill of poor readers in an orthography which is more transparent than English, for example Dutch. Phonological processing deficits may be less profound in a shallow orthography with transparent relations between phonemes and graphemes than in a deep orthography with opaque relations between phonemes and graphemes. Consequently, poor phonological skills may be less of an obstacle to the acquisition of orthographic representations in shallow orthographies. Seymour, Aro, and Erskine (2003) showed that in normal readers accuracy and speed of reading familiar words is affected by orthographic depth. Accuracy was relatively low and speed was relatively slow in French, Portugese and Danish; the performance of the English-speaking first graders fell far below the levels of first-year groups in other countries. English is classified as the deepest orthography with many multi-letter graphemes, context dependent rules and irregularities. French, Portugese and Danish are also at the deep end of the scale. "There was also evidence of orthographic depth effects [on simple nonword reading] paralleling those found for familiar words. Reductions in accuracy and fluency were apparent in French, Portugese [...] and Danish, and, to a lesser extent, Swedish and Dutch [...]. The most striking outcome was the evidence of profound delays in the development of simple decoding skills in English" (Seymour et al., p. 160). Aro and Wimmer (2003) also reported poor nonword reading accuracy for English children, but comparable nonword reading fluency. However, the English children like the Dutch and French children were among the slowest. According to Seymour et al. "there is a threshold of orthographic complexity which, once exceeded, results in a step change in the way in which literacy is acquired. Portugese, French, Danish and English are located above this threshold and the remaining languages below it" (p.168). They suggest that in deep orthographies word recognition skill develops independently of phonological decoding skill; in shallow orthographies these skills may be closely connected. Lexical reading and spelling skill may therefore develop differently in a deep orthography than in a shallow orthography. If theories of literacy acquisition are to account for data from all (alphabetic) orthographies, Dutch presents an interesting case. There is a rather straightforward mapping of graphemes to phonemes, but there also are several one-phoneme-to-two-graphemes correspondences (e.g., /ɛi/ → ij, ei; /t/ → d, t). (See Chapter 2 for a brief description of Dutch orthography.) However, considering the regularity of the orthography, Dutch children have relatively much difficulty acquiring phonological decoding skills (see Seymour et al., 2003, Aro & Wimmer, 2003). This may affect their ability to store orthographic representations.

The present thesis *1.3*

The present thesis focuses on the acquisition and use of orthographic representations in Dutch poor readers. In its orientation the study can be said to be fundamental, but at the same time aims at practical application. It is therefore expected that the study has both theoretical and practical implications. The thesis aims at answering three focal questions:

1. Which of three orthographic difficulties causes most problems for Dutch children learning to spell? (Chapter 2)
2. Do poor readers differ from normal, beginning readers in their use of orthographic representations in reading and spelling? (Chapter 3)
3. Do lexical reading and spelling skill benefit differently from reading intervention and spelling intervention? (Chapter 4)

The first question concerns properties of Dutch. Although its orthography is considered to be fairly consistent, several sound-to-spelling inconsistencies exist (Nunn, 1998). As these inconsistencies are unidirectional, they mainly affect learning to spell. We confine ourselves to a few ambiguities that beginning spellers confront: the labio-dental fricative in word-initial position which can be represented by ‘f’ and ‘v’, the alveolar fricative in word-initial position which can be represented by ‘s’ and ‘z’, the diphthong /ɛi/ which can be represented by ‘ij’ and ‘ei’, the diphthong /ɑu/ which can be represented by ‘ou’ and ‘au’, and the phoneme /t/ in word-final position which can be represented by ‘t’and ‘d’. In Chapter 2 we examine to what extent children in first and second grade have problems in spelling these sounds. To evaluate children’s knowledge of this part of Dutch orthography, a computerised spelling test is developed in addition to a written spelling test. Our results show that Dutch children have less difficulty in spelling word-initial /s’/ and /f’/ than in spelling /ɛi/ and /ɑu/ and that they have more difficulty in spelling word-final /t/ than in spelling /ɛi/ and /ɑu/.

The second question concerns a comparison of normal and deviant reading and spelling development. Most Dutch studies on literacy acquisition focus on normal readers (Bast, 1995; Bosman, 1994; de Graaff, 1995) or on the phonological (decoding) skills of poor readers (Irausquin, 1997; Kerstholt, 1995; Van den Bosch, 1991; Van den Broeck, 1997; Wentink, 1997; Wesseling, 1999). Yap (1993) examined whether poor readers have a deficit in phonological decoding skills, automatic word processing skills, or both. One study explored various aspects of orthographic knowledge of poor readers. Using visual matching tasks and a letter detection task, Knuijt (2001) examined normal and poor readers' knowledge of frequent combinations of letters, often referred to as multiletter units. Knuijt did not include word-specific orthographic knowledge in his study. Assink, Bos, and Kattenberg (1996) provide some information on normal and poor readers' orthographic processing skill. (See Chapter 3 for a detailed discussion of this study.) We examine in Chapter 3 whether poor readers differ from normal, beginning readers in their use of orthographic representations in reading and spelling and phonological representations in reading. The use of orthographic representations is assessed by comparing accuracy and naming speed of high-frequency words containing an ambiguous phoneme and the corresponding pseudohomophones. The use of phonological representations is assessed by comparing accuracy and naming speed of pseudohomophones and pseudowords. Normal and poor readers appear to behave similarly.

The third question concerns the mode of acquisition of lexical representations. Several training studies have been conducted with poor readers of Dutch. Van Daal (1993) for example examines a number of computer programmes designed to treat reading and spelling problems. However, only one study concerns lexical reading and spelling skill (Van Daal & Van der Leij, 1992). (See Chapter 4 for a detailed discussion of this study.) In Chapter 4 we examine whether the means through which lexical knowledge is acquired—by reading a word repeatedly or by spelling it a number of times—affects the utility of the representation for reading and for spelling. Reading and spelling practice are implemented on a computer to enable the children to practise independently. Words are practised 8, 4, or 0 times. An effect of practice frequency on reading speed and spelling accuracy will be taken as an indication that the lexical route is used. Pre- and posttests are administered to measure the effect of the training. The reading results tentatively suggest that representations that have been constructed during reading practice are more useful for reading than representations that have been constructed during spelling practice. The spelling results suggest that lexical representations that have been constructed during reading practice are equally useful for spelling as representations that have been constructed during spelling practice.

2

Difficulties in acquiring Dutch orthography

In the present study we explore some of the difficulties children experience in acquiring Dutch orthography. We examined whether first and second graders have as much difficulty in spelling word-initial /s'/ and /f'/ as in spelling /ɛi/ and /ɑu/ (choosing between etymological spelling variants), and whether they have less difficulty in spelling word-final /t/ (choosing between morphological spelling variants). We also examined whether children's knowledge of the spelling of simple words is better than their knowledge of the spelling of complex words. We administered a computerised spelling test and a written spelling test. In the computerised spelling test spoken words and pairs of homophonous graphemes were presented to the child, who had to decide as fast and accurately as possible which grapheme should be used in the word in question. In the written spelling test the children were required to fill in missing graphemes in word frames (e.g., p__n for "pijn', __abriek for "fabriek"). Our results show that Dutch children have less difficulty in spelling word-initial /s'/ and /f'/ than in spelling /ɛi/ and /ɑu/, which in the majority of cases occupied medial positions. It is unclear whether the advantage of /s'/ - /f'/ over /ɛi/ - /ɑu/ lies in their identity or in their position. Furthermore, our results unexpectedly show that Dutch children have more difficulty in spelling word-final /t/ than in spelling /ɛi/ and /ɑu/. This suggests that they do not use morphological information in spelling. Finally, our results suggest that first graders' knowledge of the spelling of simple words is better than their knowledge of the spelling of complex words. The orthographic complexity of words had a much smaller effect on spelling accuracy in second graders. The effect of orthographic complexity may reflect differences in exposure to specific words.

"Inherently, alphabetic spelling systems reflect the spoken language at the level of phonology. Yet, although some come closer than others, virtually no spelling system achieves a perfect one-phoneme-to-one-grapheme relationship. Orthographies may deviate from phonology to reflect aspects of phonetics, morphology, syntax, and etymology, and many exceptions are in fact historical artifacts or simply encoding imperfections. Alphabetic orthographies differ considerably in the degree of complexity of their phoneme-grapheme correspondences and in their spelling conventions" (Caravolas, 1993, p. 186). In *French* and *English* there are many one-phoneme-to-many-graphemes and many-phonemes-to-one-grapheme correspondences. According to Caravolas, this is in part the result of the fact that these languages reflect their old spoken forms. Also, they encode morphological as well as phonological information. Orthographies such as French and English are called opaque. *Italian* and *Spanish* on the other hand are highly transparent orthographies. The phoneme-grapheme correspondences are for the most part context-independent; "that is a given grapheme represents only one phoneme regardless of its position in the word and of the graphemes that precede or follow it" (Caravolas, p.186). *German* and *Dutch* take up a position in between. Caravolas refers to these orthographies as quasi-regular. There exists a rather straightforward mapping of the grapheme set onto the phoneme set, but there also are several one-phoneme-to-many-graphemes correspondences. In the present study we will explore some of the difficulties children experience in acquiring Dutch orthography.

The source of inspiration to this study was Nunn's (1998) description of the generalizations about Dutch spelling. Te Winkel's principles formed the starting point of Nunn's description. "The Phonological Principle imposes a one-to-one mapping between phonemes and graphemes. However, the Phonological Principle is sometimes violated. For this reason Te Winkel formulated additional principles and rules. […] The Principle of Uniformity implies that spelling abstracts from the effect of sound rules such as Final Devoicing in order to provide a uniform representation for morphemes. If the effect of rules were represented, spelling would be less uniform: **strant – stranden*. Spelling thus represents the abstract sound representation that underlies both surface realizations. […] The Principle of Uniformity implies that orthography does not only abstract from the effect of allophonic rules, but also from the effect of sound rules that change one phoneme into another. Dutch spelling is thus not phonemic but morpho-phonemic. […] If the spelling is compared with the abstract sound representation, i.e. the sound representation of the constituting morphemes of complex words, it becomes clear that there is a closer approximation to a one-to-one relation between phonemes and graphemes. A second class of violations of the Phonological Principle consists of competing spellings such as *ij* or *ei* (*r**ij**k – r**ei**k*) for /ɛi/. These spelling variants once corresponded to a sound contrast that has disappeared. To account for these facts, Te Winkel proposed the Principle of Etymology. […] According to this principle, the choice between competing spelling variants is motivated by the history of the words." (p. 18-19) Lastly, there is the Principle of Analogy. "This principle is similar to the Principle of Uniformity, but it applies to affixes instead of free morphemes. It prescribes the spelling *station**s**straat* because of *station**s**weg* and *hij word**t*** because of *hij loop**t***, although two adjacent identical consonants are normally reduced to one by Degemination. I will refer to the combination of the Principle of Uniformity and the Principle of Analogy as the Morphological Principle." (p. 20)

"Discussion of Te Winkel's approach reveals that divergences of the one-to-one correspondence can be divided into three categories. The Morphological Principle causes spelling variants that are only apparent and disappear if we consider spelling to be a code for the pronunciation of morphemes. Real spelling variants can be subdivided into competing spelling variants described by the Principle of Etymology and conditioned, context-sensitive spelling variants for which no spelling principle was introduced." (p. 22) Examples of these three categories are listed below:

Types of spelling variants [2]

Apparent variants

t, p	*d – t, b – p*	*woor**d** – poor**t**, we**b** – ste**p***
s	*ss – s*	*stations**s**straat – stations**s**weg*

Real variants

a Competing (etymological) variants

ɛi	*ij – ei*	***fij**n – g**ei**t*
ɑu	*ou – au*	*t**ou**w - g**au**w*

b Conditioned variants

j	*j – i*	***j**oel – loe**i***
w	*w – uw*	***w**ee – ee**uw***
ɑu	*ou – ouw*	*k**ou**d – vr**ouw***
	au – auw	*kl**au**ter – l**auw***

In the present study we will restrict ourselves to apparent (morphological) variants and real (etymological) variants. We selected words ending in /t/ and words containing /ɛi/ or /ɑu/. Spellers need to access the lexical representation of these words. If the distinction between morphological and etymological spelling variants has psychological value, words like *woord* should be easier to spell than words like *geit* and *gauw*. In support of this

2 This does not conclude Nunn's (1998) description of the spelling of native Dutch words. The phoneme-to-grapheme conversion rules, which relate abstract sound representations to abstract spelling representations, are supplemented with a set of autonomous spelling rules. These rules manipulate letter sequences, and thus describe the relation between abstract and surface spelling.

prediction, Treiman, Cassar, and Zukowski (1994) show that first and second graders to some extent use morphological information in spelling. Children tend to spell flaps as voiced (e.g., *cidy* for *city*), probably because the phonetic forms of flaps are voiced. However, children were more accurate at spelling the flaps of words such as *dirty*, which have a stem ending with /t/, than the flaps of words such as *city*. In the former case, the word's morphology provides the correct spelling of the flap. Treiman et al. showed that children use meaning relations among words (*dirty – dirt*) to aid their spelling before they have formally been taught to do so. Children may implicitly or explicitly use their knowledge of the word's morphology in spelling. With respect to the spelling of word-final /t/ in Dutch, the underlying morphological representation of a word can be made audible by producing the inflected form of the word (/wort/ → /wordə/, /port/ → /portə/).

We were also interested in children's ability to spell words beginning with /s/, /z/, /f/ or /v/. In standard Dutch the voiceless and voiced alveolar fricatives are represented by the graphemes 's' and 'z', and the voiceless and voiced labio-dental fricatives are represented by the graphemes 'f' and 'v'. So there appears to be a one-to-one correspondence between phonemes and graphemes, and children therefore should have no difficulty in spelling these phonemes. The difference in pronunciation between the voiceless and voiced counterparts has disappeared, however, in many Dutch speakers. From a psychological point of view, the phonemes /s'/ and /f'/ may behave like /ɛi/ and /ɑu/. In the present study we examined whether first and second graders have as much difficulty in spelling word-initial /s'/ and /f'/ as in spelling /ɛi/ and /ɑu/ (choosing between etymological spelling variants), and whether they actually have less difficulty in spelling word-final /t/ (choosing between morphological spelling variants). We compared children's accuracy and speed of spelling these ambiguous phonemes. We are aware that phoneme identity covaries with phoneme position, and we will make allowance for this in interpreting the results.

As a sideline, we examined whether children's knowledge of the spelling of simple words is better than their knowledge of the spelling of complex words. For this purpose we compared children's accuracy and speed of spelling ambiguous phonemes that are part of simple monosyllabic words (CVC), complex monosyllabic words (CCVC / CVCC) or bisyllabic words.

Method 2.2

Participants 2.2.1

Participants were 30 first graders (13 male and 17 female; mean age 7;0 years) and 30 second graders (13 male and 17 female; mean age 7;11 years) who were selected from three first-grade classrooms and three second-grade classrooms of a single primary school. All children were native speakers of Dutch. They scored in the top 75 % on a standardised reading achievement test and on a standardised spelling achievement test.

Materials 2.2.2

Spelling test. We selected 80 words containing one or two ambiguous phonemes. As 17 words had a double ambiguity, there were 97 word items (i.e., combinations of a word and an ambiguous phoneme). All words were selected from Staphorsius et al. (1988). This is a frequency count of printed words in Dutch books and textbooks for children from 7 to 13 years old. The corpus contains 202,526 words. Selected words occurred more than 14 times and less than 100 times in the corpus.

Thirty-one of the words contained one of the ambiguous phonemes /s'/ or /f'/ in word-initial position (mean frequency count: 35.39). The phoneme /s'/ was represented by the grapheme 's' in 2 words and by the grapheme 'z' in 8 words. The phoneme /f'/ was represented by the grapheme 'f' in 7 words and by the grapheme 'v' in 14 words.

Thirty-three of the words contained one of the ambiguous phonemes /ɛi/ or /ɑu/ (mean frequency count: 37.97). In most words the phonemes occupied medial positions. In three words /ɛi/ or /ɑu/ occupied word-initial position; in four words /ɛi/ or /ɑu/ occupied word-final position. The phoneme /ɛi/ was represented by the grapheme 'ij' in 13 words and by the grapheme 'ei' in 10 words. The phoneme /ɑu/ was represented by the grapheme 'ou' in 7 words and by the grapheme 'au' in 3 words.

Thirty-three of the words contained the phoneme /t/ in word-final position (mean frequency count: 34.15). The phoneme /t/ was represented by the grapheme 't' in 15 words and by the grapheme 'd' in 18 words.

The ambiguous phonemes were part of words of varying orthographic complexity. In 32 cases the ambiguous phoneme was part of a simple monosyllabic word (CVC; mean frequency count: 30.19); in 36 cases the ambiguous phoneme was part of a monosyllabic word containing one or two consonant clusters (CCVC / CVCC / CCVCC; mean frequency count: 39.42); in 29 cases the ambiguous phoneme was part of a bisyllabic word (mean frequency count: 37.66).

The children were also required to spell a number of pseudowords containing an ambiguous phoneme. This allows us to determine whether they have a preference for either of the homophonous graphemes that can be used to represent the phoneme. We constructed 30 pseudowords, of which 6 contained the phoneme /s'/ in word-initial position, 6 contained the phoneme /f'/ in word-initial position, 6 contained the phoneme /ɛi/, 6 contained the phoneme /ɑu/, and 6 contained the phoneme /t/ in word-final position. In each set, two of the pseudowords were simple monosyllables (CVC), two were monosyllables containing one consonant cluster (CCVC / CVCC), and two were bisyllables. Appendix A presents the materials used in this experiment.

All words and pseudowords were read on tape by a female speech therapist. She was asked not to discriminate between 's-' and 'z-' and between 'f-' and 'v-'. In order to rule out any differences in pronunciation, we selected an instance of the phoneme /s'/ and fitted it into the recordings of the other (pseudo)words beginning with 's' or 'z'. The same procedure was followed with the phoneme /f'/. The recordings of the (pseudo)words were digitised for presentation on the computer.

Table 2.1 Number of word items.

	Item type			
Item type	/s'/ - /f'/	/ɛi/ - /ɑu/	/t/	total
simple monosyllables	10	12	10	32
complex monosyllables	14	6	16	36
bisyllables	7	15	7	29
total	31	33	33	

Reading test. A standardised word reading test, the 'Drie-Minuten-Toets' [Three-Minutes-Test] (Verhoeven, 1992), was also administered. This test consists of three lists of isolated words of increasing difficulty. The first list is made up of monosyllabic words of simple orthographic structure (CVC, CV or VC). The second list is made up of monosyllabic words containing one or two consonant clusters. The third list is made up of words of two, three or four syllables. The children were asked to read the words as fast and accurately as possible. The score for each list is the number of words read correctly in one minute. This test was administered by the teachers. In accordance with standard test procedures, first graders only read the first list.

Procedure *2.2.3*

The children spelled each word item on four occasions, two times in a computerised spelling test and two times in a written spelling test. They spelled each pseudoword item on two occasions, once in a computerised spelling test and once in a written spelling test. The order in which the tests were administered is shown in table 2.2. It took three months (April - June) to collect all data.

Table 2.2 Order and time of testing.

Spelling test	Round	Number of ambiguities in words	Number of ambiguities in pseudowords	Testing period
computer	1	97	15	1 month
written	1	97		2 weeks
computer	2	97	15	1 month
written	2	97		2 weeks
written			30	2 days

In the <u>computerised spelling test</u> spoken words and pairs of homophonous graphemes were presented to the child, who had to decide as fast and accurately as possible which grapheme should be used in the word in question. (A Macintosh Classic II computer was used.) Presentation of each item was preceded by an auditory attention signal. After 500 ms two boxes appeared side by side in the center of the screen. The boxes were 2.5 cm high and 6.0 cm wide, and were 1.0 cm apart. Either box contained one of the homophonous graphemes. Black, lower case letters (typeface: Helvetica 36) were used on a white background. The various graphemes were 0.7 to 1.2 cm high and 0.5 to 1.5 cm wide. Four seconds after the graphemes had appeared on the screen, the spoken word was presented. The child indicated which grapheme she thought was the correct one by pressing one of two marked keys on the keyboard of the computer. The left-hand key corresponded with the grapheme in the box on the left side; the right-hand key corresponded with the grapheme in the box on the right side. The child was instructed to hold her index fingers on the keys all through the session, to be able to respond quickly. A maximum of 30 seconds was allowed for responding. On pressing one of the keys, the corresponding box was highlighted for a moment. Then the boxes were erased. After one second an auditory signal was given to call the child's attention to the next trial. Accuracy was registered and decision latency (i.e., the time between the point the spoken word could be uniquely identified and the response of the child) was measured.

There were two rounds of spelling trials. In each round all 97 word items and half (15) of the pseudoword items were presented. The children were not informed about the presence of pseudowords in the spelling test. The word items were ordered for presentation in such a way that the various ambiguous phonemes to be spelled (/s'/, /f'/, /ɛi/, /ɑu/, /t/) and the graphemes that would correctly represent these phonemes were distributed evenly over the round of spelling trials. Orthographically complex words alternated with orthographically less complex words. (Appendix B presents an example of the order of presentation of the items. Every seventh or eighth item was a pseudoword. Average positions in this sequence are given for all item types.) The location (left-hand box or right-hand box) of the grapheme that would correctly represent the ambiguous phoneme was varied systematically but unpredictably. For the second round, the order of presentation of the items was reversed and in all items the two homophonous graphemes were transposed.

Each round of spelling trials was divided into two or three sessions of approximately 20 minutes. The sessions were scheduled on different days. The words with a double ambiguity were presented two times in a round, once with either pair of homophonous graphemes, but not in the same session. The computerised spelling test was administered individually in a separate room in the school.

In the written spelling test words and pseudowords were presented in separate sessions and in different formats. The words were printed on a sheet of paper without the graphemes representing the ambiguous phonemes (e.g., p___n for "pijn", ___abriek for "fabriek"). The words with a double ambiguity were printed with two blanks, one for each ambiguous phoneme (e.g., __r__w for "vrouw", __an__ for "zand"). In order to prevent misspellings due to misidentification of the spoken word, the word was presented in the context of a sentence. Then the target word was pronounced separately by the experimenter. She was asked not to discriminate between ‘s-’ and ‘z-’ and between ‘f-’ and ‘v-’. The children were required to fill in the missing grapheme(s) in the word frame. They were given the opportunity to correct any self-detected spelling errors.

There were two rounds of spelling trials. In each round all 80 words—of which 17 had a double ambiguity—were presented. Each round was divided into four sessions, which were scheduled on different days. All item types were distributed evenly over the sessions. The order of presentation of the words was random and the same for all children.

The 30 pseudowords were presented in a separate session. The initial 10 pseudowords were simple monosyllables (CVC). They were followed by 10 more complex monosyllables (CCVC / CVCC). The final 10 pseudowords were bisyllables. The experimenter pronounced each pseudoword twice. Again, the experimenter was asked not to discriminate between ‘s-’ and ‘z-’ and between ‘f-’ and ‘v-’. The children had to write down the entire pseudoword. The written spelling tests were administered in small groups in a separate room in the school.

Results 2.3

The children in first grade were divided into two groups of equal size on the basis of their scores on the first list of the standardised word reading test (“poor” readers: reading level 1; good readers: reading level 2). The children in second grade were divided into two groups of about equal size on the basis of their scores on the three lists of the standardised word reading test (“poor” readers: reading level 3; good readers: reading level 4). Table 2.3 presents mean scores.

The data of three participants were excluded from the analyses. Two of them appeared to have mild hearing difficulties, and the third one was repeatedly found out copying from the others in the written spelling test. The data of three more participants were excluded from the analyses of decision times. Two of them did not continuously hold their index fingers on the response keys. The third one broke his right arm at some point in the testing period, and thereafter pressed either response key with his left index finger.

Table 2.3 Mean scores on the three lists of the standardised word reading test (standard deviations in parentheses).

	Grade							
	1				2			
	Reading level				Reading level			
	1 (n = 15)		2 (n = 15)		3 (n = 14)		4 (n = 16)	
List 1	13.9	(2.1)	24.3	(5.4)	56.9	(8.0)	79.4	(11.0)
List 2					41.8	(10.1)	66.6	(8.5)
List 3					29.7	(7.0)	49.9	(9.0)

The children spelled each word item on four occasions, two times in the written spelling test and two times in the computerised spelling test. They spelled each pseudoword item on two occasions, once in the written spelling test and once in the computerised spelling test. The two spelling tests were analysed separately. For all item types we counted the number of word items spelled correctly on two trials, and calculated the mean. This is the observed score. The score may be due in part to fortuitous selection of the correct grapheme. Our next step therefore was to calculate the score a child would reach solely by guessing. For each phoneme we determined whether the child had a preference for either of the homophonous graphemes. Each phoneme occurred in six pseudoword items. The strength of a preference was computed by dividing six into the number of times that a particular grapheme was used to represent the phoneme. On the basis of the strength of a preference we calculated the probability of spelling a word item correctly on two trials (see table 2.4). For all item types we added up the “probabilities” of the word items, and calculated the mean. This is the expected score[3] when a child has no knowledge of the spelling of any of the words. The observed score minus the expected score is hereafter termed “knowledge score”.

Table 2.4 Calculating the probability of spelling a word item correctly on two trials.

		Strength of preference	Probability correct on two trials	“**fij**n”	“g**ei**t”
strong preference for ‘ij’ over ‘ei’	ij	$^6/_6$	$^6/_6 * {}^6/_6 =$	$^{36}/_{36}$	
	ei	$^0/_6$	$^0/_6 * {}^0/_6 =$		$^0/_{36}$
slight preference for ‘ij’ over ‘ei’	ij	$^4/_6$	$^4/_6 * {}^4/_6 =$	$^{16}/_{36}$	
	ei	$^2/_6$	$^2/_6 * {}^2/_6 =$		$^4/_{36}$
no preference for either ‘ij’ or ‘ei’	ij	$^3/_6$	$^3/_6 * {}^3/_6 =$	$^9/_{36}$	
	ei	$^3/_6$	$^3/_6 * {}^3/_6 =$		$^9/_{36}$

In the computerised spelling test decision latency was measured. Our first step was to determine “combined” decision time for each word item. In case a correct response was given on both spelling trials, the mean of the decision times was calculated. In case a correct response was given on only one of the spelling trials, the “combined” decision time equals the decision time for the correct response. In case no correct response was given on either spelling trial, a missing value was assigned for “combined” decision time. Our next step was to calculate the median of the “combined” decision times for /s’/ - /f’/, /ɛi/ - /ɑu/, and /t/, and for the simple monosyllabic words, the complex monosyllabic words, and the bisyllabic words. Median decision times were calculated for a subject only if in at least a third of the cases one or two correct responses were given.

3 Thirty-three of the words contained one of the ambiguous phonemes /ɛi/ or /ɑu/. The phoneme /ɛi/ was represented by the grapheme ‘ij’ in 13 words and by the grapheme ‘ei’ in 10 words. The phoneme /ɑu/ was represented by the grapheme ‘ou’ in 7 words and by the grapheme ‘au’ in 3 words. In case a child has a slight preference for ‘ij’ over ‘ei’ and a strong preference for ‘ou’ over ‘au’, the expected score for /ɛi/ - /ɑu/ is 42 $((((13 * {}^{16}/36) + (10 * {}^{4}/36) + (7 * {}^{36}/36) + (3 * {}^{0}/36)) / 33)*100 = 42)$.

Preliminary analyses on subjects' knowledge scores included the factor test (written test vs. computerised test). The main effect of test was highly significant, indicating that the children scored higher on the written spelling test than on the computerised spelling test. As each analysis revealed a significant three-way interaction (test x item type x reading level) and a significant interaction between test and item type and between test and reading level, we decided to perform analyses separately for each spelling test. Two analyses of variance were performed on subjects' knowledge scores on the written spelling test and on subjects' knowledge scores on the computerised spelling test, with item type as a within-subjects factor and reading level (1, 2, 3, 4) as a between-subjects factor. Furthermore, two analyses of variance were performed on subjects' median decision times with item type as a within-subjects factor and grade (1, 2) as a between-subjects factor. Item type consisted of three levels ((a) *phoneme identity:* /s'/ - /f'/ vs. /ɛi/ - /ɑu/ vs. /t/, (b) *orthographic complexity:* simple monosyllables vs. complex monosyllables vs. bisyllables).

Phoneme identity 2.3.1

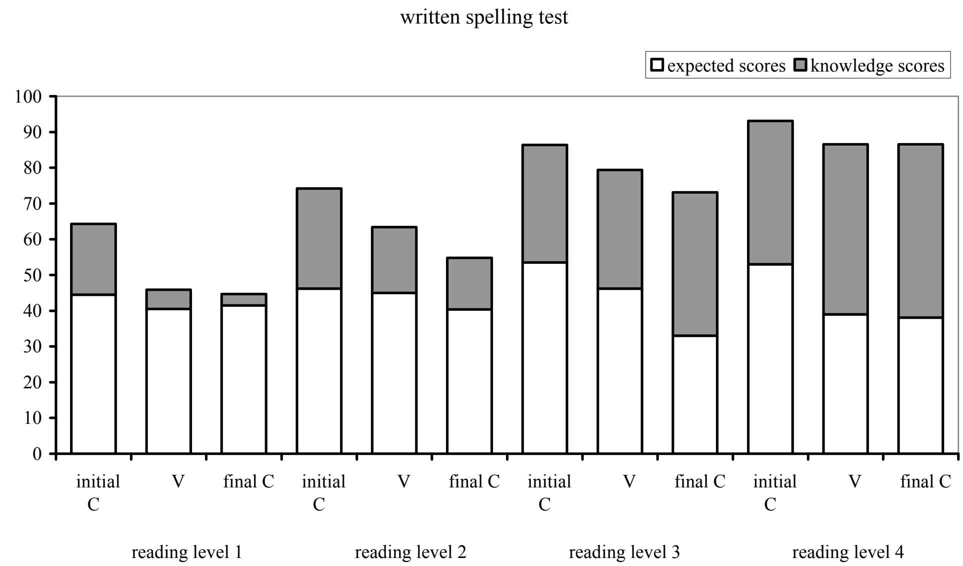
Knowledge scores. The main effect of reading level was significant in both tests (written test: $F(3,53) = 44.13$, $p < .001$; computerised test: $F(3,53) = 21.75$, $p < .001$). Knowledge scores increased with reading level (written test: 9.3, 20.1, 35.5, 45.5 for the children at reading level 1, 2, 3, and 4 respectively; computerised test: 7.5, 16.1, 18.4, 37.4 for the children at reading level 1, 2, 3, and 4 respectively). In the *written test*, the main effect of item type was not significant ($F(2,106) = 1.40$, $p > .25$), but the interaction between reading level and item type was ($F(6,106) = 3.43$, $p < .01$). Additional analyses were carried out, which revealed a significant effect of item type at reading level 1 and a marginally significant effect of item type at reading level 2 (see table 2.5). Post hoc analyses were carried out according to the Newman-Keuls method. At reading level 1, knowledge scores were higher for /s'/ - /f'/ than for /ɛi/ - /ɑu/ and were higher for /s'/ - /f'/ than for /t/. At reading level 2, the post hoc analysis did not show any significant difference between the three item types. In the *computerised test*, the main effect of item type was significant ($F(2,106) = 13.78$, $p < .001$), and the interaction between reading level and item type was not ($F < 1$). A post hoc analysis carried out according to the Newman-Keuls method showed that knowledge scores were higher for /s'/ - /f'/ than for /t/.

Table 2.5 *F* values and significance levels for the main effect of item type and Newman-Keuls significance levels for pairs of means.

			Written spelling test		
RL	Df	Item type	/s'/ - /f'/ vs. /ɛi/ - /ɑu/	/ɛi/ - /ɑu/ vs. /t/	/s'/ - /f'/ vs. /t/
1	(2,24)	5.52 *	*	-	*
2	(2,26)	2.67 +	-	-	-
3	(2,26)	1.12 -	-	-	-
4	(2,30)	2.02 -	-	-	-

RL: reading level; +: $.05 < p < .10$; *: $p < .05$

To eliminate any effect of word frequency on accuracy of spelling /s'/ - /f'/, /ɛi/ - /ɑu/, and /t/, we examined the effect of phoneme identity within words. Seventeen words had a double ambiguity. Seven words contained either /s'/ or /f'/ in word-initial position and contained the phoneme /t/ in word-final position (voet, vriend, vreemd, feest, fruit, zand, soort). Knowledge scores were higher for /s'/ - /f'/ than for /t/ in the written spelling test (31.1 vs. 23.9; $F(1,53) = 4.50$, $p < .05$) as well as in the computerised spelling test (24.5 vs. 17.6; $F(1,53) = 3.49$, $p = .07$). Five words contained either /s'/ or /f'/ in word-initial position and one of the phonemes /ɛi/ or /ɑu/ (fijn, vijf, vrij, veilig, vrouw). Knowledge scores were higher for /s'/ - /f'/ than for /ɛi/ - /ɑu/ in the written spelling test (32.4 vs. 18.7; $F(1,53) = 7.51$, $p < .01$) but not in the computerised spelling test (17.6 vs. 22.7; $F(1,53) = 1.15$, $p > .25$). Five words contained one of the phonemes /ɛi/ or /ɑu/ and also the phoneme /t/ in word-final position (hout, koud, goud, geit, eiland). Knowledge scores were higher for /ɛi/ - /ɑu/ than for /t/ in the written spelling test (55.7 vs. 38.5; $F(1,53) = 20.76$, $p < .001$) as well as in the computerised spelling test (37.9 vs. 25.2; $F(1,53) = 12.93$, $p < .01$).



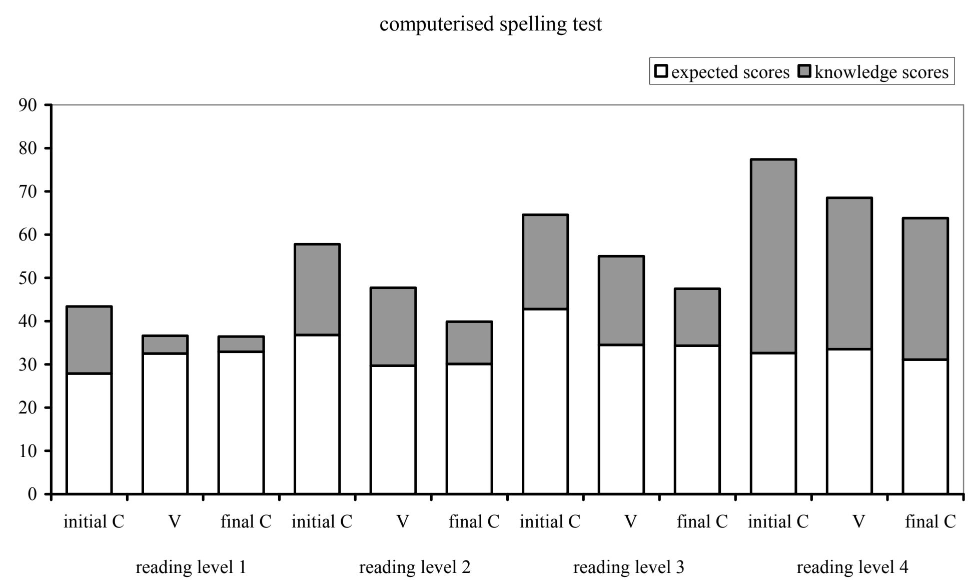


Figure 2.1 Knowledge scores for consonants in word-initial position (initial C), and vowels (V), and consonants in word-final position (final C) at reading level 1 to 4.

Decision times. The main effect of grade was not significant ($F < 1$). The main effect of item type was significant ($F(2,104) = 25.15$, $p < .001$). The interaction between grade and item type was not significant ($F(6,104) = 1.62$, $p > .20$). A post hoc analysis carried out according to the Newman-Keuls method showed that decision times were shorter for word-initial /s'/ and /f'/ than for word-final /t/.

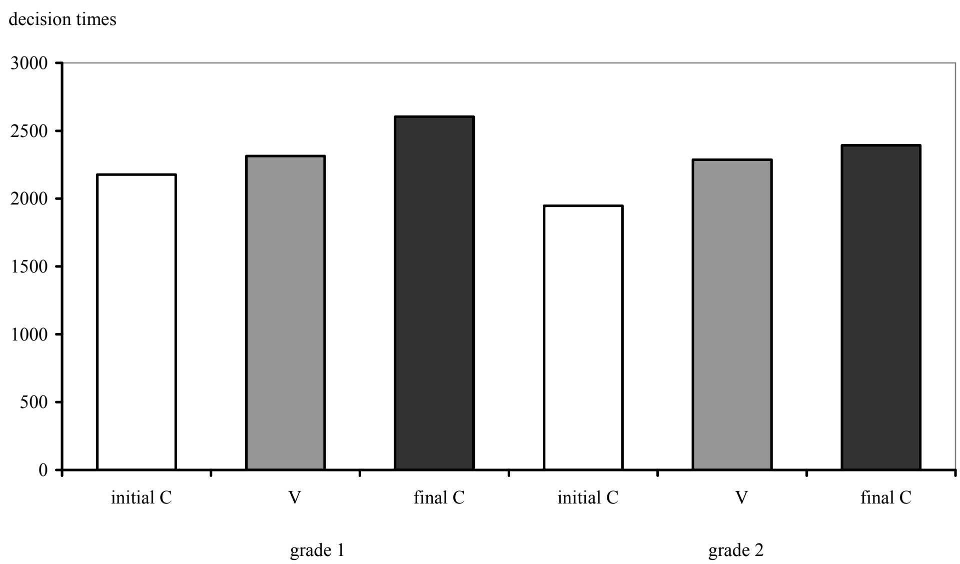


Figure 2.2 Decision times for consonants in word-initial position (initial C), and vowels (V), and consonants in word-final position (final C) for grade 1 and 2.

Orthographic complexity *2.3.2*

Knowledge scores. The main effect of reading level was significant in both tests (written test: $F(3,53) = 45.77$, $p < .001$; computerised test: $F(3,53) = 22.51$, $p < .001$). Knowledge scores increased with reading level (see above). The main effect of item type was also significant in both tests (written test: $F(2,106) = 18.32$, $p < .001$; computerised test: $F(2,106) = 28.05$, $p < .001$). This effect was qualified by a significant interaction between reading level and item type (written test: $F(6,106) = 12.40$, $p < .001$; computerised test: $F(6,106) = 2.30$, $p < .05$).

Additional analyses were carried out, which revealed a significant effect of item type at reading level 1, 2, and 4 (see table 2.6). Post hoc analyses were carried out according to the Newman-Keuls method. At reading level 1, both in the written test and in the computerised test knowledge scores were higher for the simple monosyllabic words than for the complex monosyllabic words and were higher for the simple monosyllabic words than for the bisyllabic words; in the computerised test knowledge scores were also higher for the complex monosyllabic words than for the bisyllabic words (see table 2.6). At reading level 2, both in the written test and in the computerised test knowledge scores were higher for the simple monosyllabic words than for the bisyllabic words; in the written test knowledge scores were also higher for the simple monosyllabic words than for the complex monosyllabic words and were higher for the complex monosyllabic words than for the bisyllabic words (see table 2.6). At reading level 4, the post hoc analyses did not show any significant difference between the three item types.

Table 2.6 *F* values and significance levels for the main effect of item type and Newman-Keuls significance levels for pairs of means.

				Written spelling test		
RL	Df	Item type		CVC vs. CC	CC vs. BI	CVC vs. BI
1	(2,24)	15.82	***	*	-	*
2	(2,26)	26.95	***	*	*	*
3	(2,26)	1.36	-	-	-	-
4	(2,30)	6.33	**	-	-	-
				Computerised spelling test		
RL	Df	Item type		CVC vs. CC	CC vs. BI	CVC vs. BI
1	(2,24)	19.89	***	*	*	*
2	(2,26)	8.64	**	-	-	*
3	(2,26)	2.65	+	-	-	-
4	(2,30)	4.81	*	-	-	-

RL: reading level; +: .05 < p < .10; *: p < .05; **: p < .01; ***: p < .001

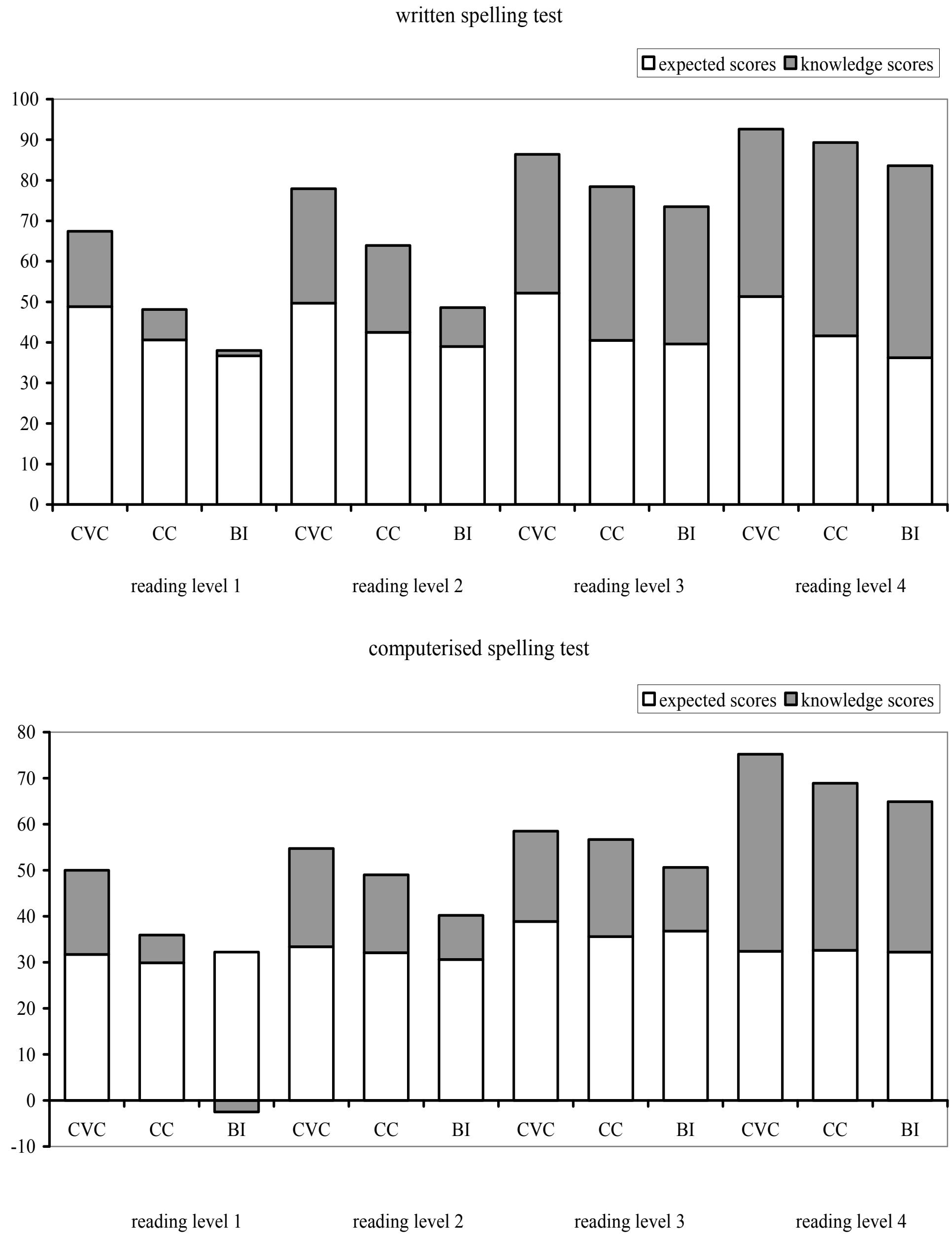


Figure 2.3 Knowledge scores for simple monosyllabic words (CVC), and complex monosyllabic words (CC), and bisyllabic words (BI) at reading level 1 to 4.

Decision times. The main effect of grade was not significant ($F < 1$). The main effect of item type was significant ($F(2,104) = 9.56$, $p < .001$). This effect was qualified by a significant interaction between grade and item type ($F(6,104) = 4.22$, $p < .05$). Additional analyses were carried out, which revealed a significant effect of item type at grade 1 ($F(2,52) = 3.82$, $p < .05$) and at grade 2 ($F(2,52) = 9.75$, $p < .001$). Post hoc analyses carried out according to the Newman-Keuls method, however, did not show any significant difference between the three item types.

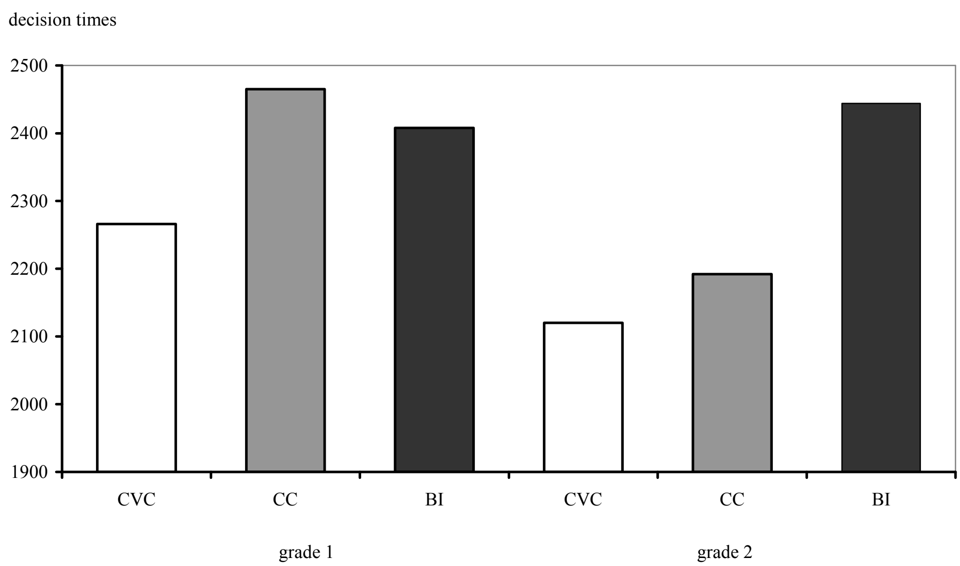


Figure 2.4 Decision times for simple monosyllabic words (CVC), and complex monosyllabic words (CC), and bisyllabic words (BI) for grade 1 and 2.

Discussion *2.4*

In the present study we examined whether first and second graders have as much difficulty in spelling word-initial /s'/ and /f'/ as in spelling /ɛi/ and /ɑu/ (choosing between etymological spelling variants), and whether they have less difficulty in spelling word-final /t/ (choosing between morphological spelling variants). We administered a written spelling test and a computerised spelling test. In the written test, an effect of phoneme identity was found at reading level 1. Knowledge scores were higher for /s'/ - /f'/ than for

/ɛi/ - /ɑu/ and were higher for /s'/ - /f'/ than for /t/. In the computerised test, an overall effect of phoneme identity was found. The effect was the same at all reading levels, as was indicated by the absence of an interaction between reading level and item type. Knowledge scores were higher for /s'/ - /f'/ (26.6) than for /t/ (15.6). Knowledge scores for /ɛi/ - /ɑu/ were at an intermediate level (20.2). The same pattern of results was obtained with the "within-word" analyses. The analysis of decision times also revealed an effect of phoneme identity. The effect was the same in both grades, as was indicated by the absence of an interaction between grade and item type. Decision times were shorter for /s'/ - /f'/ (2062 ms) than for /t/ (2499 ms). Decision times for /ɛi/ - /ɑu/ were at an intermediate level (2300 ms).

Our results show that first and second graders have less difficulty in spelling word-initial /s'/ - /f'/ than in spelling /ɛi/ - /ɑu/, which in the majority of cases occupied medial positions. One interpretation would be that the difference between 's' and 'z' and between 'f' and 'v' is still present in actual pronunciation (in the dialect of the participants) or in the underlying phonological representation. Another interpretation would be that the phonemes /s'/ and /f'/ are ambiguous in their spelling to the same extent as the phonemes /ɛi/ and /ɑu/, but that the position of the phoneme in the word affects children's knowledge of their spelling. We will discuss the role of phoneme position later. Contrary to expectation, we found that first and second graders have *more* difficulty in spelling word-final /t/ than in spelling /ɛi/ and /ɑu/. Unlike Treiman, Cassar, and Zukowski (1994) we found no evidence that the children use morphological information in spelling. An explanation for the absence of an effect of morphology in the present study may be that it is more difficult for children to produce the inflected form of root words (e.g., /wort/ → /wordə/ in Dutch), than to retrieve the stem of inflected words (e.g., /d3ːdi/ → /d3ːt/ in English).

The role of phoneme position in spelling is given attention by Treiman, Berch, and Weatherston (1993), who examined whether children's ability to use phoneme-grapheme correspondences in spelling *nonwords* is affected by the position of the phoneme in the word or syllable. They showed that initial consonants (compare /s'/ - /f'/ in our study) were easier to spell than medial vowels (compare /ɛi/ - /ɑu/ in our study) and final consonants (compare /t/ in our study). So far, their results are consistent with ours. Since English vowels typically have more alternative spellings than do consonants, we cannot be sure to what extent children's poor performance on vowels reflects their position or their identity. This observation also holds for the advantage of /s'/ - /f'/ over /ɛi/ - /ɑu/ in Dutch. With respect to the relative ease of spelling medial vowels and final consonants, our results are opposite to Treiman et al.'s. They found that final consonants were spelled more accurately than medial vowels. Again, we cannot be sure to what extent children's poor performance on vowels reflects their position or their identity. The following results shed more light on the role of phoneme position. "Children's performance on the first syllables of bisyllabic nonwords reflects the finding that phonemes in the middles of stimuli, such as the /b/ of /nɛb'tof/, are difficult to spell. Comparable syllable-final phonemes at the edges of stimuli, such as the /b/ of /'tofnɛb/, are easier to spell. Further evidence of an effect of word edges on spelling accuracy is that syllable-initial consonants appeared to be spelled more accurately when at the beginning of a nonword, as with the /n/ of /nɛb'tof/, than when in the middle of a nonword, as with the /n/ of /'tofnɛb/. Thus, when the position of a phoneme in its syllable is held constant, phonemes at either edge of a stimulus are easier to spell than phonemes in the middle of a stimulus" (Treiman, et al., p. 472). According to Treiman et al., "position effects may reflect children's phonological analysis abilities, in particular their ability to access various phonemes in nonwords" (p. 476). In the present study we used real words instead of nonwords. In order to spell Dutch words containing /ɛi/, /ɑu/, or word-final /t/, children need to access the lexical representation. The lexical spelling process may be affected differently by phoneme position than the phonological spelling process. This needs further investigation.

We also examined whether children's knowledge of the spelling of simple words is better than their knowledge of the spelling of complex words. At reading level 1, both in the written spelling test and in the computerised spelling test knowledge scores were higher for the simple monosyllabic words than for the complex monosyllabic words and were higher for the simple monosyllabic words than for the bisyllabic words; in the computerised spelling test knowledge scores were also higher for the complex monosyllabic words than for the bisyllabic words. At reading level 2, both in the written test and in the computerised test knowledge scores were higher for the simple monosyllabic words than for the bisyllabic words; in the written test knowledge scores were also higher for the simple monosyllabic words than for the complex monosyllabic words and were higher for the complex monosyllabic words than for the bisyllabic words. These results suggest that first graders' knowledge of the spelling of simple words is better than their knowledge of the spelling of complex words. At the higher reading levels, the orthographic complexity of words had a much smaller effect on spelling accuracy.

The analysis of decision times revealed an effect of orthographic complexity in grade 1 and in grade 2. The effect was not the same in the two grades, as was indicated by the interaction between grade and item type. Inspection of the graph (Fig. 2.4) suggests that first graders decided on the correct grapheme most quickly for simple monosyllabic words and that second graders decided on the correct grapheme most slowly for bisyllabic words. The results suggest that the orthographic representations of words of simple orthographic structure are more readily accessed in the mental lexicon than those of words of complex orthographic structure.

A critical observation is in place. In order for the orthographic representation of a word to be stored in the mental lexicon the word must be encountered in print. The number of times that a word is encountered presumably contributes to the quality of the orthographic representation. The simple monosyllabic words, the complex monosyllabic words, and the bisyllabic words occurred approximately equally often in a corpus of words taken from Dutch books and textbooks for children from 7 to 13 years old. The corpus may not be representative of first and second graders' reading vocabulary, however. The frequency of words in this corpus may not be an appropriate measure of the number of times the participants had encountered the words to be spelled. Words of simple orthographic structure probably are encountered more often by beginning readers than words of complex orthographic structure. The effect of orthographic complexity may reflect differences in exposure to specific words.

In summary, we found that children's knowledge of the spelling of simple words is better than their knowledge of the spelling of complex words, and that Dutch children have less difficulty in spelling word-initial /s'/ - /f'/ than in spelling /ɛi/ - /ɑu/, and less difficulty in spelling /ɛi/ - /ɑu/ than in spelling word-final /t/.

A final aspect of the present study that needs consideration is the use of two different spelling tests. Although similar patterns were found in the written spelling test and the computerised spelling test, the children consistently scored higher on the written test than on the computerised test. The tests differed in a number of respects, all of which operate in favour of the written spelling test. In the written test the words were presented in the context of a sentence; in the computerised test isolated words were presented. In the written test the words were presented visually without the graphemes representing the ambiguous phonemes (e.g., p__n for "pijn"); in the computerised test no visual support was given. In the written test no time limit was set; in the computerised test the children were instructed to respond quickly. In the written test the children were given the opportunity to correct self-detected spelling errors; in the computerised test error correction was not possible. Different as these tasks are, they reveal a similar pattern of results.

From considerations of practicality, we employ a written spelling test in the following studies. As this test can be administered in groups, less time is needed for testing. To approach the normal spelling process more closely, the children are required to spell the entire word. To examine children's ability to acquire orthographic representations and use them in reading and spelling, we employ words containing /ɛi/ or /ɑu/ which are of simple orthographic structure in the following studies. Word-initial /s'/ and /f'/ are not suited for this purpose, because they may not be ambiguous in their spelling and spellers may not need to access the orthographic representation of these words. Word-final /t/ does not suit our purposes, because older children—despite poor reading skills—may make better use of morphological information than first and second graders.

3

The phonological and orthographic processing skill of normal and poor readers

In the present study we examined whether normal and poor readers use orthographic representations and phonological representations in reading aloud and whether they do so to the same extent. The use of orthographic representations was measured by comparing accuracy and speed of naming high-frequency words containing one of the ambiguous phonemes /ɛi/ or /ɑu/ to accuracy and speed of naming the corresponding pseudohomophones. The use of phonological representations was measured by comparing accuracy and speed of naming pseudohomophones to accuracy and speed of naming pseudowords that had been created from them. We also examined whether Dutch poor readers are poor at reading pseudowords. This was examined by comparing normal and poor readers' accuracy and speed of naming simple pseudowords. Finally, we examined whether normal and poor readers use orthographic representations in spelling and whether they do so to the same extent. The proportion of correct spellings of words containing /ɛi/ or /ɑu/ provides a measure of the extent to which the children use orthographic representations in spelling. Participants were 61 normal readers (36 first graders, mean age 7;0 years; 25 second graders, mean age 8;0 years) and 72 reading-level matched poor readers (mean age 9;2 years). Only for the children at the highest reading level we could reliably demonstrate that orthographic representations were used in reading. Still, at each reading level normal and poor readers were found to behave similarly. We also found that the normal and poor readers (at all reading levels) to the same extent use phonological representations in reading aloud. Our results did not provide evidence for a pseudoword reading deficit in Dutch poor readers. The spelling data are inconclusive.

According to dual-route theory two routes can be used to generate a word's pronunciation: the phonological route and the lexical route (see section 1.1). The phonological route must be used with words of which no graphemic pattern is stored in the mental lexicon and with nonwords. It is generally acknowledged that the phonological processing skill of poor readers is impaired (e.g., Gillon & Dodd, 1994, 1997; Masterson, Hazan, & Wijayatilake, 1995; McDougall, Hulme, Ellis, & Monk, 1994; Sprenger-Charolles, Cole, Lacert, & Serniclaes, 2000). Therefore, they are expected to perform poorly on nonwords (see section 3.1.1). The lexical route crucially depends on the presence and good quality of orthographic and phonological representations. It has frequently been suggested that poor readers have imprecise or poorly specified phonological representations (e.g., Elbro, Borstrøm, & Petersen, 1998; Snowling, Wagtendonk, Stafford, 1988; Swan & Goswami, 1997). This may interfere with the efficacy of the lexical route. The quality and accessibility of orthographic representations, however, probably more strongly influence the effectiveness of the lexical route. In section 3.1.2 and 3.1.3 a number of studies on poor readers' orthographic processing skill are reviewed. In the present study, we examine whether poor readers differ from normal, beginning readers in their use of phonological representations in reading and orthographic representations in reading and spelling.

Phonological deficit *3.1.1*

Rack, Snowling, and Olson (1992) reviewed 16 studies that examined whether poor readers have a deficit in phonological reading skill, which in all studies was assessed by means of a nonword reading task. The central question was whether poor readers' ability to read nonwords was worse than could be expected on the basis of their word recognition skill. Ten studies showed that poor readers were indeed worse than younger, reading-level matched normal readers on nonword reading; six studies did not find evidence for a nonword reading deficit. However, in a quantitative meta-analysis of these studies Van IJzendoorn and Bus (1994) showed that the *combined* effect size for nonword reading for the latter studies was significant, and that the two subsets of studies were not taken from different populations. The overall combined effect size for the 16 studies was highly significant. The meta-analysis thus supports the idea that poor readers have a phonological deficit.

Rack et al. (1992) suggested that the complexity of the nonwords and the similarity of the nonwords to real words to some extent may account for the differences between studies. Simple nonwords or nonwords that closely resemble real words may not be very sensitive to phonological reading skill. However, Van IJzendoorn and Bus (1994) showed that the type of nonwords in the test did not determine effect size. Another factor that may have contributed to the different outcomes of the studies is the type of intelligence test used for matching. According to Rack et al., "subjects whose reading is poor despite good verbal abilities may represent a particularly clear group [of poor readers] in whom nonword reading skill is deficient" (p. 43). Purely verbal intelligence tests are therefore supposed to create a better match between normal and poor readers than mixed verbal /

performance tests. Furthermore, the reading tests that were used to match normal and poor readers on word recognition skill may not all be adequate. Reader groups who are matched on a test which presents words in context, may differ in context-free single-word recognition skill; reader groups who are matched on a test which presents *regular* words in isolation, may be unlikely to differ on nonword reading (Rack et al., 1992). Indeed, Van IJzendoorn and Bus showed that the type of intelligence test and the type of reading test used to match normal and poor readers were related to the effect sizes for nonword reading skill.

The studies included in the Rack et al. (1992) review and the Van IJzendoorn and Bus (1994) meta-analysis concern the English language. In view of the *regularity* issue raised above, it is of importance to examine whether it is possible to demonstrate a nonword reading deficit in a language with a regular orthography, such as Dutch. Yap and Van der Leij (1993) had Dutch disabled readers (10;2 years) and reading-level matched poor and normal readers (8;2 years and 7;1 years respectively) read CVC words and nonwords. The (non)words were presented with and without time constraint to examine whether processing was automatized. The disabled readers made more errors than the poor and normal readers in naming nonwords *and* in naming words, but they were particularly impaired in naming nonwords which were presented at a short exposure duration. Yap and Van der Leij concluded that the disabled readers have a deficit in *automatic* phonological reading skills. However, as the disabled readers were also impaired in naming words, the reading-level match seems inadequate and conclusions should be regarded with caution. Van der Leij and Van Daal (1999) had Dutch poor readers (10;0 years) and reading-level matched normal readers (8;0 years) read words and nonwords of varying complexity. The poor readers performed at the accuracy and latency level of the normal readers when naming familiar words. However, their accuracy and speed of naming CVC and CVCCVC nonwords was much lower than that of the normal readers. So, there is some evidence for a nonword reading deficit in Dutch poor readers. In the present study we try to further substantiate this claim.

Elbro, Borstrøm, and Petersen (1998) suggested that the acquisition of phonological reading skill is influenced by the quality of phonological representations in the mental lexicon. They found that children who performed poor on nonword reading at the beginning of second grade (N = 23) at the beginning of kindergarten had phonological representations which were less distinct than those of children with good nonword reading skill (N = 68). Furthermore, the measure of distinctness of phonological representations predicted individual variance in nonword reading. According to Elbro et al. “the effect may be due to the possibility that distinctness of the phonological representations is a determinant of access to phonological segments, and that the extraction of grapheme-phoneme correspondences from successful exposures to print rests on the access to phonological segments" (p.53). The quality of phonological representations may also affect the operation of the lexical route. In the present study we examine whether normal beginning readers and reading-level matched poor readers use phonological representations in reading aloud and whether they do so to the same extent.

As was pointed out in the introduction of this chapter, the quality and accessibility of orthographic representations probably more strongly influence the efficacy of the lexical route. In section 3.1.2 and 3.1.3 we review a number of studies on poor readers' orthographic processing skill.

Superior orthographic skill *3.1.2*

The poor readers in a reading-level match design are older than the normal readers and therefore have been exposed more often to written language. Consequently, they have had more opportunity to develop orthographic skill.[4] Indeed, a number of studies suggest that poor readers can compensate for their phonological processing deficit by the development of superior orthographic processing skill.

Rack (1985) presented pairs of spoken words to poor readers (13;2 years) and to reading-level matched normal readers (10;4 years), and asked them to decide whether or not the words in each pair rhymed. One word from each pair was then presented as a cue and the children tried to recall the other word. The poor readers classified rhyming pairs that were orthographically dissimilar (e.g., head - said) more slowly than rhyming pairs that were orthographically similar (e.g., head - dead), and they recalled more words to orthographically similar cues than to orthographically dissimilar cues. No effect of orthographic similarity was found for the normal readers. Zecker (1991) also found that the reduction in response latencies for orthographically similar as opposed to orthographically dissimilar rhyme pairs in an auditory rhyme detection task was larger for older poor readers (10;1 to 11;5 years) than for younger normal readers (7;0 to 8;5 years). These results may be interpreted in several ways. The poor readers may have stored more, or more fully specified orthographic representations, or have better access to them.

4 Indeed, Cunningham and Stanovich (1990) and McBride-Chang, Manis, Seidenberg, Custodio, and Doi (1993) showed that the variation in orthographic processing skill is in part determined by individual differences in exposure to print.

Holmes and Standish (1996) described the case of an 18-year-old student (KQ) who was well below average in reading aloud and spelling words. KQ was extremely poor at nonword reading and spelling, and produced more phonologically implausible spellings than any other student in a control sample. However, she was faster than average in classifying words and nonwords in a lexical decison task, and was above average in identifying the correct spelling of a word when presented together with a homophonic nonword (e.g., deep - deap). KQ was much better at recognising correct spellings of words than she was at producing them. Still, she was more likely than any other student in the control sample to have all the letters present in her spelling attempt except for a misordering. The data suggest that, despite her phonological processing deficit, KQ was comparatively proficient at accessing orthographic representations stored in her mental lexicon.

Poor orthographic skill *3.1.3*

As opposed to the studies considered in the previous section, a number of studies report that poor readers perform poorly on tasks measuring orthographic processing skill. Stanovich and Siegel (1994) found that poor readers were better than statistically matched[5] normal readers at recognising which of four alternatives (e.g., time, teim, tihm, tiem) represents the correct spelling of a word. However, they were worse at identifying the correct spelling of a word in pairs of homophonic letter strings (e.g., rain, rane). Because the latter task supposedly is more sensitive to differences in word-specific orthographic knowledge, these results suggest that the poor readers have stored fewer, or less specified orthographic representations. This conclusion is corroborated by several other studies.

Foorman, Francis, Fletcher, and Lynn (1996) administered a spelling recognition test involving words and homophonic nonwords (e.g., rain, rane; bowl, boal) and a spelling production test involving words with exceptional patterns to assess children's knowledge of the spelling of words. After variability caused by decoding skill was eliminated, poor readers were found to have a lower level of word-specific orthographic knowledge relative to normal readers. Alegria and Mousty (1996) administered a spelling production test involving high-frequency and low-frequency words containing an ambiguous phoneme. They found that poor readers (9;4 to 14;5 years) produced fewer correct spellings of the

5 "Statistical matching" means that the variance due to overall reading level was regressed out as a predictor of the criterion variable.

ambiguous phonemes than reading-level matched normal readers (6;9 to 11;4 years), and that the effect of word frequency was weaker in the former group. This finding suggests that the poor readers did not use word-specific orthographic knowledge in spelling to the same extent as the normal readers.

Ehri and Saltmarsh (1995) conducted a training study that addressed normal and poor readers' ability to store orthographic representations and use them for reading. Beginning readers (6;8 years) and older poor readers (9;1 years) were taught to read words having simplified phonetic spellings (e.g., MESNGR for 'messenger'). Three days later they read originally learned spellings and spellings in which one letter had been altered (e.g., MESNJR). Poor readers' performance was compared with the performance of first graders reading at a higher level and of first graders reading at a lower level. Of interest to us is whether poor readers' performance on the posttest was consistent with their reading level. Original spellings were read faster than some types of altered spellings, indicating that the children were reading the words by lexical access: first graders who were reading at a low level were sensitive to letter alterations in medial as well as initial and final positions of words, whereas the poor readers were sensitive only to initial and final letter alterations. This suggests that the orthographic representations stored by the poor readers are less specified than the representations stored by the younger normal readers.

Landerl, Frith, and Wimmer (1996) matched normal readers (8;2 years) and poor readers (12;3 years) for number of correct spellings of words containing a silent letter, thus warranting the assumption that the orthographic representations of the words were equally specified in both groups. The normal readers more often than the poor readers were misled by their knowledge of word spellings in counting the number of phonemes of a word (e.g., W<u>H</u>AT → four, instead of three) and in deleting the first or final phoneme of a word (e.g., W<u>H</u>AT → /hot/, instead of /ot/). The explanation Landerl et al. offered for this difference between normal and poor readers was that the connection between phonological and orthographic representations of words is less strong in the poor readers, so that word-specific orthographic knowledge interferes less with phonemic segmentation.

These studies suggest that poor readers have stored fewer, or less specified orthographic representations than normal readers, and that in poor readers the orthographic representations are only weakly connected with the phonological representations.

One Dutch study provides information on poor readers' orthographic processing skill. Assink, Bos, and Kattenberg (1996) had poor readers (12;1 years) and reading-level matched normal readers (8;9 years) read meaningful sentences and random word strings containing a misspelled word. Misspellings were created by substituting one letter in bisyllabic words. Three types of letter substitutions were used: sound preserving (t/d), orthographically legal (m/n), and orthographically illegal (c/e). The poor readers were slightly worse at detecting illegal substitutions than the normal readers (76% vs. 78%). Having correctly identified the word containing a misspelling, the poor readers were less accurate than normal readers in locating the misspelled letter in the word (11% vs. 7% incorrect). Detection rates for the legal substitutions (38%) and the sound-preserving substitutions (22%) were similar for the poor and normal readers. These results suggest that the poor readers are somewhat less sensitive to the graphotactic constraints of Dutch. However, the normal and poor readers do not seem to differ in their knowledge of the spelling of words or their ability to compare actual spellings with stored spellings. In view of the low detection rate for the sound-preserving substitutions (on average 5,3 of 24), the task seems too difficult for both reader groups and therefore may not be suited to detect differences between normal and poor readers. Another explanation for the absence of a reader group effect may be that Dutch poor readers—in consequence of the regular orthography—find few difficulties in acquiring orthographic representations. The contradictory results in section 3.1.2 (superior orthographic skill) and section 3.1.3 (poor orthographic skill in the English studies / normal orthographic skill in the Dutch study) motivated us to examine whether Dutch poor readers use stored orthographic representations in reading and spelling and whether they do so to the same extent as normal readers.

The present study 3.1.4

Three research questions were addressed in the present study. The <u>first</u> question was whether normal and poor readers use orthographic representations in reading and spelling and whether they do so to the same extent. The use of orthographic representations in *reading* was measured by comparing accuracy and speed of naming high-frequency words containing one of the ambiguous phonemes /ɛi/ or /ɑu/ (e.g., fijn, touw) and the corresponding pseudohomophones (e.g., fein, tauw). An advantage of words over pseudohomophones would be an indication that stored orthographic representations are used. We must make a reservation here. In most of the words /ɛi/ and /ɑu/ were represented by the graphemes 'ij' and 'ou' respectively[6], and in most of the pseudohomophones /ɛi/ and /ɑu/ were represented by the graphemes 'ei' and 'au' respectively. The "orthographic representation" interpretation will only hold if the effect cannot be attributed to the children being more familiar with 'ij' and 'ou' than with 'ei' and 'au'. This was examined by comparing children's reading performance on pseudowords that had been created from the words (e.g., f**ij**p, t**ou**s) and on pseudowords that had been created from the pseudohomophones (e.g., f**ei**p, t**au**s). The proportion of correct spellings of words containing /ɛi/ or /ɑu/ provides a measure of the extent to which normal and poor readers use orthographic representations in *spelling*. The second question was whether normal and poor readers use phonological representations in reading aloud and whether they do so to the same extent. The use of phonological representations was measured by comparing accuracy and speed of naming pseudohomophones (e.g., fein, tauw) and pseudowords that had been created from them (e.g., feip, taus). An advantage of pseudohomophones over pseudowords would be an indication that stored phonological representations are used. The third question was whether Dutch poor readers exhibit a pseudoword (= nonword) reading deficit. This was examined by comparing normal and poor readers' accuracy and speed of naming simple pseudowords (e.g., fijp, feip, tous, taus).

6 To increase the probability that the normal, beginning readers and the poor readers have stored the orthographic representations of the words, we selected high-frequency words of simple orthographic structure (CVC). The imbalance between homophonous graphemes in the word set is unavoidable.

Method 3.2

Participants 3.2.1

Participants were 36 first graders (14 male and 22 female; mean age 7;0 years) and 25 second graders (10 male and 15 female; mean age 8;0 years) who were selected from two primary schools, and 72 children with reading and spelling difficulties (54 male and 18 female; mean age 9;2 years) who were selected from three schools for special education. They were selected on the basis of their scores on a standardised reading achievement test. (The test is described in the procedure section.) The children attending a primary school were selected if their score was above grade average or in the range of 25% just below grade average. The children attending a school for special education were selected if their score was in the range of 25% lowest achieving pupils of the grade they would be in considering their age. The groups were matched for reading level as measured by the standardised reading achievement test. All children were native speakers of Dutch.

Materials 3.2.2

All words were selected from Staphorsius, Krom, and De Geus (1988). This is a frequency count of printed words in Dutch books and textbooks for children from 7 to 13 years old. The corpus contains 202,526 words. Appendix C presents the materials used in this experiment.

(Pseudo)words containing /ɛi/ *or* /ɑu/. We selected 21 high-frequency words (with a printed frequency count of more than 14) containing one of the ambiguous phonemes /ɛi/ or /ɑu/. In most words the phoneme /ɛi/ was represented by the grapheme ‘ij’, and in most words the phoneme /ɑu/ was represented by the grapheme ‘ou’. The words were of simple orthographic structure (CVC, CV or VC). The corresponding homophonic pseudowords (pseudohomophones) were created by replacing ‘ij’ with ‘ei’ or ‘ei’ with ‘ij’, and ‘ou’ with ‘au’ or ‘au’ with ‘ou’. We created 42 pseudowords by changing or deleting the final consonant of the 21 words and pseudohomophones, or by adding one when the word and pseudohomophone were of CV structure. The same change was made in a word and its corresponding pseudohomophone. Therefore the two resulting pseudowords were homophonic.

Distractors. Two types of distractors were used. (**A**) We selected 21 high-frequency words (with a printed frequency count of more than 14) that are spelled with ‘v’ or ‘z’ at word-initial position or with ‘g’, ‘d’ or ‘t’ at word-final position. The words were of simple orthographic structure (CVC or CV). “Homophonic” pseudowords were created by replacing ‘v’ with ‘f’, ‘z’ with ‘s’, ‘g’ with ‘ch’, ‘d’ with ‘t’, and ‘t’ with ‘d’. We created 42 pseudowords by changing the vowel of the 21 words and the corresponding “homophonic” pseudowords. These words and pseudowords were included to distract the subjects’ attention from the (pseudo)words containing one of the ambiguous phonemes /ɛi/ or /ɑu/. (**B**) We also selected 36 high-frequency words (with a printed frequency count of more than 14) and 38 low-frequency words (with a printed frequency count of less than 6) containing a consonant cluster. Half of the high-frequency words and half of the low-frequency words were of CCVC structure; the other words were of CVCC structure.

In the reading test all words, pseudohomophones, and pseudowords were presented to the child. In the spelling test only the real words were presented. In order to prevent misspellings due to misidentification of the spoken word, sentence contexts were constructed for each of the 116 real words. All words used in these sentence contexts were regarded as familiar in meaning to six-year-old children by at least 75 percent of Dutch teachers in kindergarten and first grade (Kohnstamm, Schaerlaekens, de Vries, Akkerhuis, & Frooninckxs, 1981).

Procedure 3.2.3

The experiment was conducted in a three-week period starting in the beginning of January on one primary school and in a six-week period starting in the beginning of February on the other school. On the three schools for special education the experiment was conducted in an eight-week period starting in the beginning of October.

A *standardised reading achievement test*, the ‘Drie-Minuten-Toets’ [Three-Minutes-Test] (Verhoeven, 1992), was administered to determine the reading level of the participants. This test consists of three lists of isolated words of increasing difficulty. The first list is made up of monosyllabic words of simple orthographic structure (CVC, CV or VC). The second list is made up of monosyllabic words containing one or two consonant clusters. The third list is made up of words of two, three or four syllables. The children were asked to read the words as fast and accurately as possible. The score for each list is the number of words read correctly in one minute. The sum of the three scores is the test score.

In the experimental *reading test* the words, pseudohomophones and pseudowords were presented one by one on a computer screen. (An Apple Macintosh Plus ED computer was used at the primary schools and an Apple Macintosh Classic II computer was used at the schools for special education.) The children were asked to read all items as fast and accurately as possible. The items were presented in black, lower case letters on a white background in the center of the screen. A letter font that is used in many educational text books was chosen (Helvetica). A three-letter string was approximately 0.8 to 1.0 inches wide; a four-letter string approximately 1.0 to 1.4 inches. The letter strings were approximately 0.4 to 0.6 inches high. Each item was followed by a mask (%#&+). The mask was approximately 1.8 by 0.5 inches. The children were seated approximately 20 inches from the screen and they wore a headset. Naming times were measured by a voice-activated relay connected to the microphone of the headset.

Presentation of each item was preceded by an asterisk (500 ms) in the center of the screen. At the same time an auditory attention signal was given. After 500 ms the item appeared on the screen. Maximum presentation time was 6500 ms. As soon as the voice-activated relay was triggered by a sound, the item disappeared and the mask appeared where the item was before. The mask was on the screen for 1000 ms. Naming times were measured accurately to the millisecond. By pushing a button on a button box the experimenter registered whether the item had been read correctly and whether the clock had been stopped by the verbal response of the participant.

The test was divided into two or three sessions of approximately 20 minutes each. The children were given the opportunity to have a break whenever they wanted. The sessions were scheduled on different days. The words containing an ambiguous phoneme, the pseudohomophones, and the pseudowords were divided evenly over the sessions, as well as the high-frequency and low-frequency words containing a consonant cluster. A word and its pseudohomophone were not presented in the same session. Homophonic pseudowords were not presented in the same session either. All item types were mixed on presentation. The order of presentation of the words, pseudohomophones and pseudowords was random, and different for each participant.

In the *spelling test* the experimenter read aloud each sentence, and then pronounced the target word separately. The children were then given as much time as they needed to write down the word. They were given the opportunity to correct their spellings when they themselves thought they had made an error.

The spelling test was split into five sessions, which were scheduled on five different days. The words containing an ambiguous phoneme were divided evenly over the sessions, as well as the high-frequency and low-frequency words containing a consonant cluster. All word types were mixed on presentation. The order of presentation of the words was random and the same for all children. Each session lasted approximately 30 minutes.

The reading tests were administered individually in a quiet room in the school. The spelling test was administered collectively in the classroom.

Results *3.3*

The children were divided into four groups of about equal size on the basis of their scores on the standardised reading achievement test (1 to 40: reading level 1; 41 to 80: reading level 2; 81 to 125: reading level 3; 126 to 210: reading level 4). Table 2.1 presents mean scores on this test and for each reading level *t* test results for testing the significance of the difference between the normal and poor readers. The two groups did not differ significantly on overall reading skill.

Table 3.1 Mean scores on the Three-Minutes-Test (standard deviations in parentheses) and *t* test results for testing the significance of the difference between the two groups.

Reading level	n	Normal readers		n	Poor readers		
1	14	27.1	(7.1)	15	28.4	(8.4)	$t(27) = -.43$, *n.s.*
2	16	59.2	(12.8)	18	61.7	(9.3)	$t(32) = -.66$, *n.s.*
3	13	97.8	(14.3)	21	102.9	(15.1)	$t(32) = -.97$, *n.s.*
4	18	170.6	(22.5)	18	158.3	(20.5)	$t(34) = 1.72$, *n.s.*

Reading 3.3.1

Error percentages and median naming times were calculated for the words containing an ambiguous phoneme (e.g., fijn, touw), for the pseudohomophones (e.g., fein, tauw), for the pseudowords that had been created from the words (e.g., fijp, tous), and for the pseudowords that had been created from the pseudohomophones (e.g., feip, taus). Naming times for items that were read incorrectly and times recorded when the clock had not been stopped by the verbal response of the participant, but by another sound, were not valid and therefore were discarded. Median naming times were calculated only if at least 50% of the relevant observations were valid.

Preliminary analyses of variance included the reading level factor. Because each analysis revealed a significant three-way interaction (word type x reader group x reading level) or a significant interaction between word type and reading level and between reader group and reading level, we decided to perform analyses separately for each reading level. We present the results of these analyses. Three analyses of variance were performed on subjects' error percentages and on subjects' median naming times, with word type as a within-subjects factor and reader group as a between-subjects factor. In each of the three analyses word type consisted of two levels (a: use of orthographic representations) words vs. pseudohomophones, (b: use of phonological representations) pseudohomophones vs. pseudowords that had been created from the pseudohomophones, (c: the effect of grapheme frequency) pseudowords that had been created from the words vs. pseudowords that had been created from the pseudohomophones. Reader group also consisted of two levels (normal readers vs. poor readers).

Use of orthographic representations in reading 3.3.1a

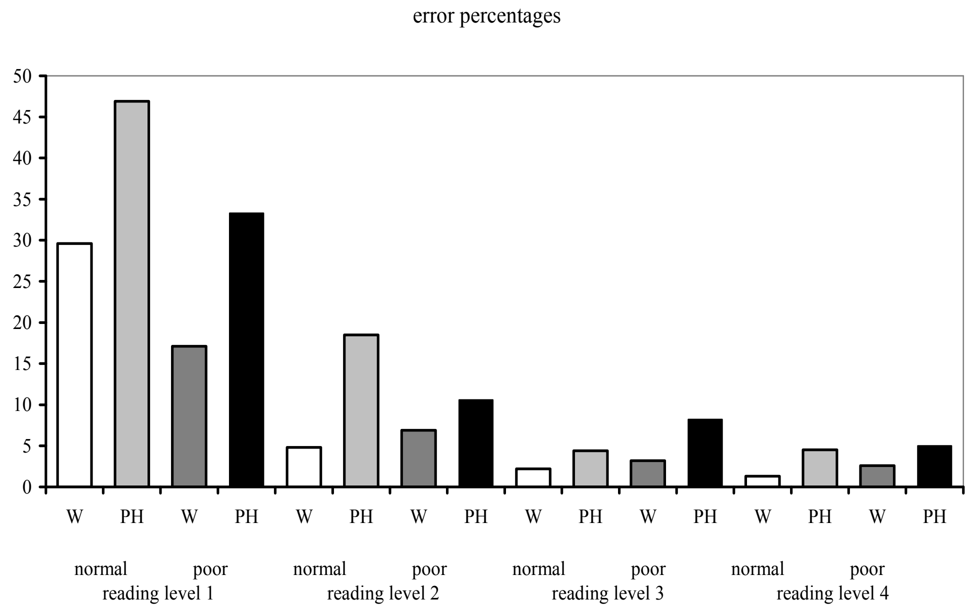
The use of orthographic representations in reading was measured by comparing accuracy and speed of naming words and the corresponding pseudohomophones. An advantage of words over pseudohomophones would be an indication that stored orthographic representations are used. Figure 3.1 presents mean error percentages and median naming times for the words (W) and pseudohomophones (PH) at each reading level. Table 3.2 presents F values and significance levels for the main effect of word type, the main effect of reader group and for the interaction effect. For ease of survey, we only report statistics for significant effects ($p < .05$) and marginally significant effects ($p < .10$).

Table 3.2 *F* values and significance levels for the main effect of word type (W vs. PH), the main effect of reader group and for the interaction effect.

Reading Level		Df	Word type		Reader group		WT x RG	
1	EP	(1, 27)	24.44	***	3.41	+	.	
	NT	(1, 15)	19.90	***	12.53	**	.	
2	EP	(1, 32)	10.37	**	.		3.42	+
	NT	(1, 31)	55.53	***	14.70	**	.	
3	EP	(1, 32)	8.11	**	.		.	
	NT	(1, 32)	28.49	***	.		.	
4	EP	(1, 34)	6.46	*	.		.	
	NT	(1, 34)	43.35	***	.		.	

EP: Error percentages; NT: Naming times
+: $.05 < p < .10$; *: $p < .05$; **: $p < .01$; ***: $p < .001$

At reading level 1, the words and the corresponding pseudohomophones were named more accurately and faster by the poor readers than by the normal readers. At reading level 2, the words and the corresponding pseudohomophones were also named faster by the poor readers than by the normal readers. At reading level 3 and 4, the poor readers performed similarly to the normal readers. At each reading level, words were named more accurately and faster than the corresponding pseudohomophones by the normal readers and the poor readers.



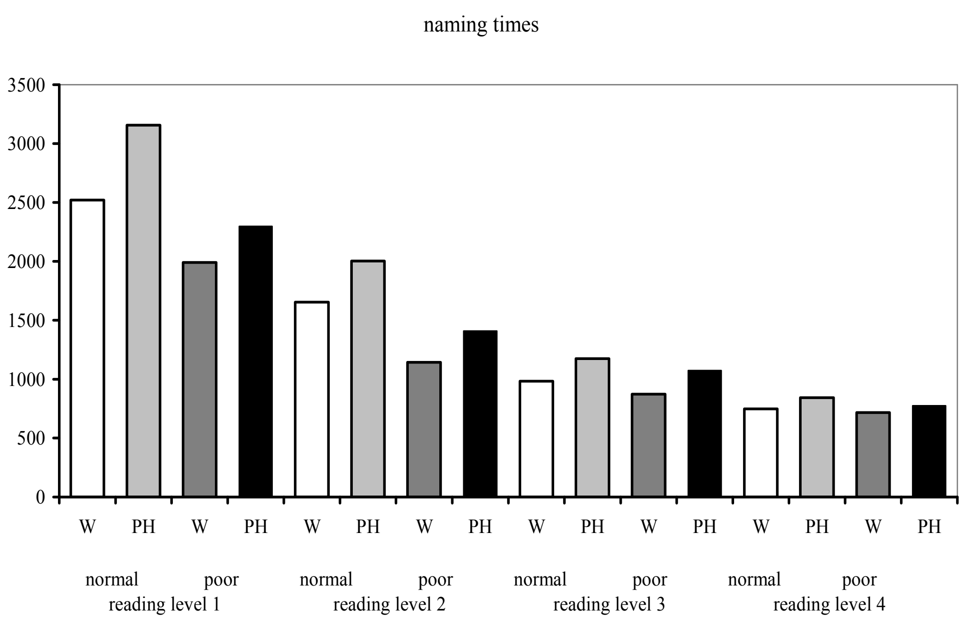


Figure 3.1 Mean error percentages and median naming times for the words (W) and pseudohomophones (PH) at reading level 1 to 4.

Use of phonological representations in reading *3.3.1b*

The use of phonological representations in reading was measured by comparing accuracy and speed of naming pseudohomophones and pseudowords that had been created from them. An advantage of pseudohomophones over pseudowords would be an indication that stored phonological representations are used. Figure 3.2 presents mean error percentages and median naming times for the pseudohomophones (PH) and the pseudowords (PW(ph)) at each reading level. Table 3.3 presents *F* values and significance levels for the main effect of word type, the main effect of reader group and for the interaction effect. For ease of survey, we only report statistics for significant effects ($p < .05$) and marginally significant effects ($p < .10$).

Table 3.3 *F* values and significance levels for the main effect of word type (PH vs. PW(ph)), the main effect of reader group and for the interaction effect.

Reading Level		Df	Word type	Reader group	WT x RG
1	EP	(1, 27)	16.62 ***	.	.
	NT	(1, 8)	11.02 *	10.44 *	.
2	EP	(1, 32)	51.77 ***	.	7.03 *
	NT	(1, 25)	48.36 ***	6.52 *	.
3	EP	(1, 32)	25.95 ***	.	.
	NT	(1, 28)	36.17 ***	.	.
4	EP	(1, 34)	15.81 ***	.	3.80 +
	NT	(1, 33)	10.30 **	.	.

EP: Error percentages; NT: Naming times
+: $.05 < p < .10$; *: $p < .05$; **: $p < .01$; ***: $p < .001$

At each reading level and by both reader groups, the pseudohomophones were named more accurately and faster than the pseudowords that had been created from them. The interaction between word type and reader group *at reading level 2* is due to the advantage of pseudohomophones over pseudowords being larger for the poor readers than for the normal readers.

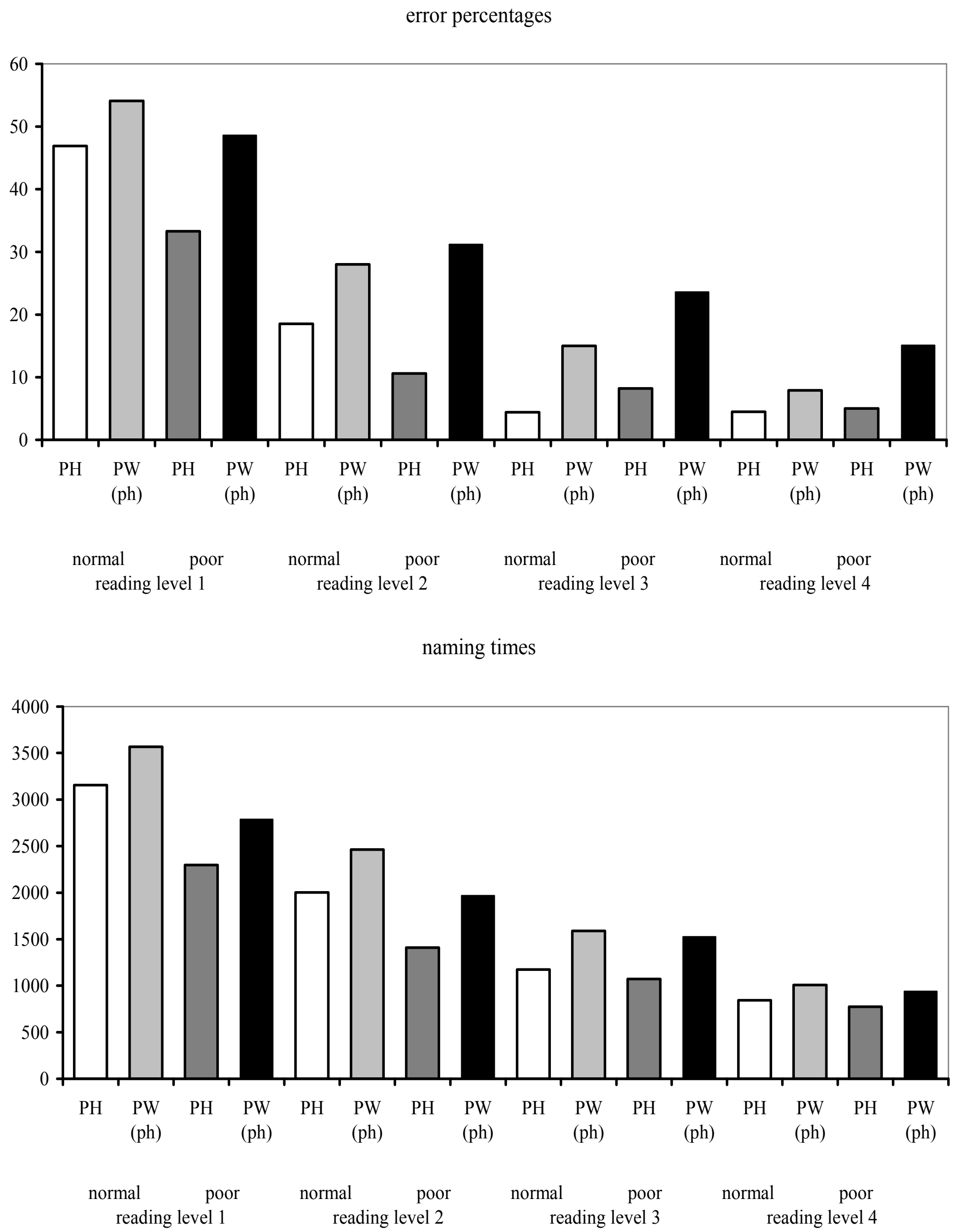


Figure 3.2 Mean error percentages and median naming times for the pseudohomophones (PH) and the pseudowords (PW(ph)) at reading level 1 to 4.

Pseudoword reading and the effect of grapheme frequency *3.3.1c*

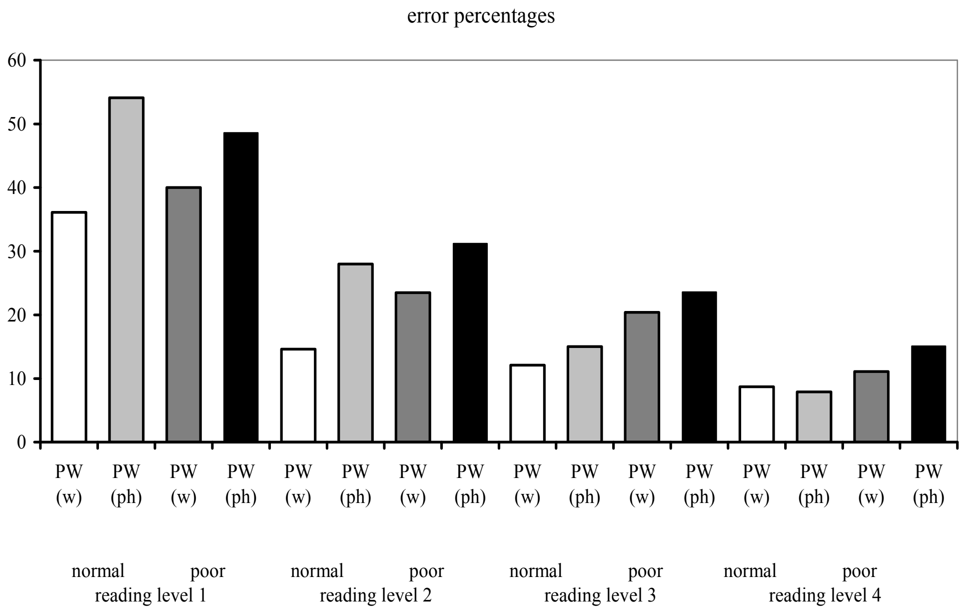
Normal and poor readers' accuracy and speed of naming (two types of) pseudowords was compared. The effect of grapheme frequency was tested by comparing children's reading performance on pseudowords that had been created from the words (e.g., f**ij**p, t**ou**s) and on pseudowords that had been created from the pseudohomophones (e.g., f**ei**p, t**au**s). Figure 3.3 presents mean error percentages and median naming times for the two types of pseudowords (PW(w) and PW(ph)) at each reading level. Table 3.4 presents *F* values and significance levels for the main effect of word type, the main effect of reader group and for the interaction effect. For ease of survey, we only report statistics for significant effects ($p < .05$) and marginally significant effects ($p < .10$).

Table 3.4 *F* values and significance levels for the main effect of word type (PW(w) vs. PW(ph)), the main effect of reader group and for the interaction effect.

Reading Level		Df	Word type	Reader group	WT x RG
1	EP	(1, 27)	24.72 ***	.	.
	NT	(1, 9)	8.51 *	3.64 +	22.14 **
2	EP	(1, 32)	12.55 ***	.	.
	NT	(1, 25)	.	.	.
3	EP	(1, 32)	.	3.29 +	.
	NT	(1, 28)	18.07 ***	.	.
4	EP	(1, 34)	.	.	.
	NT	(1, 33)	.	.	.

EP: Error percentages; NT: Naming times
+: $.05 < p < .10$; *: $p < .05$; **: $p < .01$; ***: $p < .001$

Overall, the poor readers performed similarly to the normal readers on pseudoword naming. At *reading level 1*, the pseudowords that had been created from the pseudohomophones were named faster by the poor readers than by the normal readers. At *reading level 3*, the poor readers tended to name pseudowords less accurately than the normal readers. Our results do not provide evidence for a pseudoword reading deficit in Dutch poor readers.



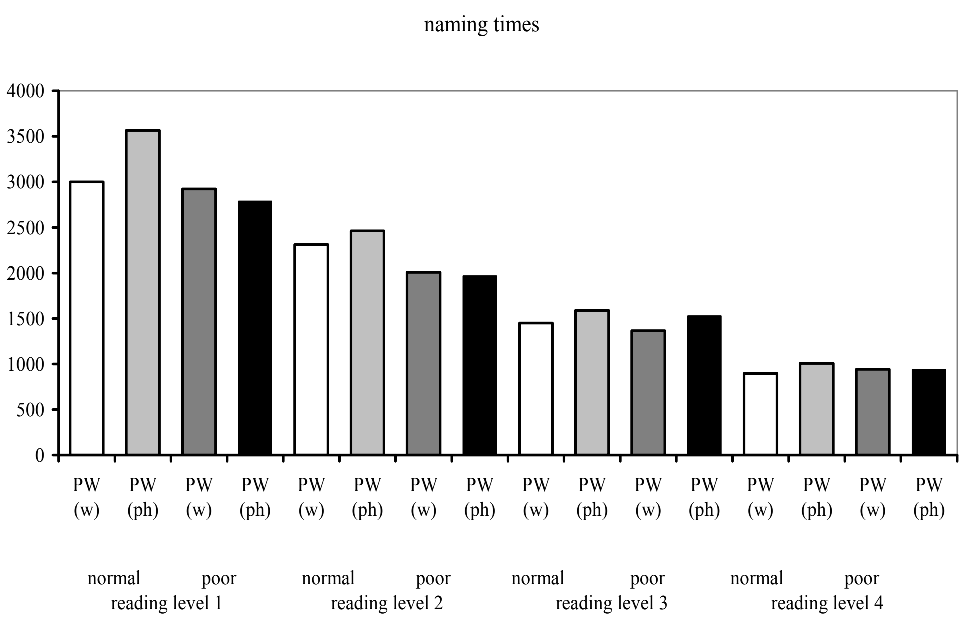


Figure 3.3 Mean error percentages and median naming times for the two types of pseudowords (PW(w) and PW(ph)) at reading level 1 to 4.

At reading level 1 and 2, the pseudowords that had been created from the words were named more accurately than the pseudowords that had been created from the pseudohomophones. At reading level 1 [7] and 3, the pseudowords that had been created from the words were named faster than the pseudowords that had been created from the pseudohomophones. These results suggest that the normal and poor readers at reading level 1, 2, and 3 are more familiar with ‘ij’ and ‘ou’ than with ‘ei’ and ‘au’. Consequently, the advantage of words over pseudohomophones (see section 3.3.1a) may not be (completely) attributable to the use of orthographic representations in reading. At reading level 4, accuracy and speed of naming pseudowords that had been created from the words and pseudowords that had been created from the pseudohomophones did not differ significantly. This suggests that the children are equally familiar with ‘ei’ and ‘au’ as with ‘ij’ and ‘ou’. The advantage of words over pseudohomophones (see section 3.3.1a) therefore is an indication that the normal and poor readers at reading level 4 use orthographic representations in reading.

Use of orthographic representations in spelling *3.3.2*

The number of correct spellings and the number of phonologically correct spellings was counted for the words containing /ɛi/ or /ɑu/. Besides /ɛi/ or /ɑu/ some of the words contained additional spelling ambiguities. (a) The phoneme /ɑu/ is sometimes analysed as a sequence of two phonemes: /ɑu/ and /w/. In some Dutch words ‘ou’ or ‘au’ indeed is followed by ‘w’. Spellers must decide whether or not to insert ‘w’ in the word in question. In case the wrong choice is made, an incorrect but phonologically correct spelling results (e.g., “gouwd” for “goud”, or “tou” for “touw”). (b) One word begins with ‘f’, one word begins with ‘v’, and one word begins with ‘z’. In standard Dutch the graphemes ‘f’ and ‘v’ represent the voiceless and voiced labio-dental fricatives and the graphemes ‘s’ and ‘z’ represent the voiceless and voiced alveolar fricatives. The distinction between the voiceless and voiced variants has disappeared, however, in many Dutch speakers. Whether to use ‘f’ or ‘v’, ‘s’ or ‘z’ now constitutes word-specific orthographic knowledge. In case the incorrect grapheme is chosen, an incorrect but phonologically correct spelling results (e.g., “vijn” for “fijn”). (c) Two words end with ‘t’ and four words end with ‘d’. The graphemes

7 In fact, only in the group of normal readers the pseudowords that had been created from the words were named faster than the pseudowords that had been created from the pseudohomophones ($F(1,4) = 17.16$, $p < .05$). The effect of word type on naming latency was not significant for the poor readers ($F(1,5) = 3.15$, $p = .14$). In view of the small number of valid observations, these results must be interpreted with caution.

‘t’ and ‘d’ represent the voiceless and voiced palatal plosives. However, at the end of a word ‘d’ is pronounced /t/. The grapheme ‘d’ is preserved in the orthography because of morphographemic considerations. Spellers must decide which grapheme to use to represent final /t/. In case the incorrect one is chosen, an incorrect but phonologically correct spelling results (e.g., “tijt” for “tijd”). Appendix D contains a list of the correct spellings and all incorrect but phonologically correct spellings of the words.

For each child the percentage of phonologically correct spellings was calculated. This provides a measure of their knowledge of phoneme-to-grapheme correspondences (PGC). We also calculated the percentage of correct spellings. To arithmetically equate children on PGC knowledge, we then calculated the proportion of correct spellings of the percentage of phonologically correct spellings. The corrected proportion of correct spellings provides a measure of the extent to which children use orthographic representations in spelling.

Mean percentages of correct spellings, and of phonologically correct spellings, and mean proportions correct are presented in table 3.5. An analysis of variance was performed on subjects’ percentages of words spelled phonologically correct and on subjects’ proportions of words spelled correctly, with reader group (normal vs. poor) and reading level (1, 2, 3, 4) as between-subjects factors. Again, we only report statistics for significant effects ($p < .05$) and marginally significant effects ($p < .10$).

Table 3.5 Mean percentages of correct spellings, and of phonologically correct spellings, and mean proportions correct (standard deviations in parentheses).

Reading level	Reader group	n	Correct		Phonologically Correct		Proportion Correct	
1	Normal	14	35.7	(16.9)	68.3	(28.7)	.52	(.13)
	Poor	15	36.9	(16.2)	71.8	(21.2)	.50	(.16)
2	Normal	16	55.4	(8.7)	93.2	(9.2)	.60	(.09)
	Poor	18	49.9	(17.6)	86.4	(15.5)	.57	(.15)
3	Normal	13	65.2	(11.9)	95.6	(10.4)	.69	(.14)
	Poor	21	66.4	(17.2)	95.6	(4.9)	.69	(.17)
4	Normal	17	76.8	(12.2)	96.4	(6.2)	.80	(.12)
	Poor	18	71.8	(14.4)	94.8	(5.1)	.75	(.13)

Phonologically correct. The main effect of reader group and the interaction between reader group and reading level were not significant. The main effect of reading level was significant ($F(3,124) = 21.81$, $p < .001$). Additional analyses were carried out, which revealed that the children at reading level 1 produced fewer phonologically correct spellings than the children at reading level 2 ($F(1,61) = 15.86$, $p < .001$), who in turn produced fewer phonologically correct spellings than the children at reading level 3 ($F(1,66) = 5.43$, $p < .05$). The children at reading level 3 produced as many phonologically correct spellings as the children at reading level 4.

Proportion correct. The main effect of reader group and the interaction between reader group and reading level were not significant. The main effect of reading level was significant ($F(3,124) = 22.46$, $p < .001$). Additional analyses were carried out, which revealed that the proportion of correct spellings increased from reading level 1 to reading level 2 ($F(1,61) = 5.01$, $p < .05$), from reading level 2 to reading level 3 ($F(1,66) = 9.81$, $p < .01$), and from reading level 3 to reading level 4 ($F(1,67) = 5.74$, $p < .05$).

Discussion *3.4*

Three research questions were addressed in the present study. The <u>first</u> question was whether normal and poor readers use orthographic representations in reading and spelling and whether they do so to the same extent. At each reading level, words (W) were named more accurately and faster than the corresponding pseudohomophones (PH). The effect was equally large for the normal readers and for the poor readers, as was indicated by the absence of an interaction between word type (W vs. PH) and reader group. The advantage of words over pseudohomophones would be an indication that stored orthographic representations are used in *reading*, provided that the effect cannot be attributed to the children being more familiar with ‘ij’ and ‘ou’ than with ‘ei’ and ‘au’. This was examined by comparing children’s reading performance on pseudowords that had been created from the words (e.g., f**ij**p, t**ou**s) and on pseudowords that had been created from the pseudohomophones (e.g., f**ei**p, t**au**s). At reading level 1 and 2, the pseudowords that had been created from the words (PW(w)) were named more accurately than the pseudowords that had been created from the pseudohomophones (PW(ph)); at reading level 1 and 3, the pseudowords that had been created from the words were named faster than the pseudowords that had been created from the pseudohomophones. These results suggest that the normal and poor readers at reading level 1, 2, and 3 are more familiar with ‘ij’ and ‘ou’ than with ‘ei’ and ‘au’. Consequently, the advantage of words over pseudohomophones may not be attributable to the use of orthographic representations in reading. Whether or not orthographic representations are used, the absence of an interaction between word type (W vs. PH, and PW(w) vs. PW(ph)) and reader group[8] suggests that the normal and poor readers behave similarly. At reading level 4, accuracy and speed of naming pseudowords that had been created from the words and pseudowords that had been created from the pseudohomophones did not differ significantly. (This was true for the normal readers and for the poor readers, as was indicated by the absence of an interaction between word type (PW(w) vs. PW(ph)) and reader group.) This suggests that the children are equally familiar with ‘ij’ and ‘ou’ as with ‘ei’ and ‘au’. The advantage of words over pseudohomophones therefore is an indication that the normal and poor readers at reading level 4 use stored orthographic representations in reading aloud familiar words, and that they do so to the same extent.

At each reading level, the normal and poor readers produced equal numbers of phonologically correct spellings and equal proportions of correct spellings. In the introduction, we assumed that the proportion of correct spellings of words containing /ɛi/ or /ɑu/ provides a measure of the extent to which the children use orthographic representations in *spelling*. However, upon closer inspection of the word set we realised that the children may have attained their accuracy levels without referring to stored orthographic representations. Recall that in most of the words /ɛi/ and /ɑu/ must be represented by the graphemes ‘ij’ and ‘ou’ respectively. In appendix D it is illustrated that a strong preference for these dominant graphemes results in a .55 probability of spelling all words correctly. An additional bias to leaving out ‘w’ when /ɑu/ is followed by a consonant results in a probability of .60. When a child has learned the morphographemic rule that can be used to decide on ‘t’ or ‘d’ to represent /t/ in word-final position (*singular* /gɛit/, *plural* /gɛi**t**en/ → gei**t**; *singular* /tɛit/, *plural* /tɛi**d**en/ → tij**d**), the probability of spelling all words correctly is as high as .74. The proportion of correct spellings increased from .51 at reading level 1 to .78 at reading level 4, which does not differ significantly from .74 ($t(34) = 1.62$, $p = .11$). Therefore, we cannot be certain whether or to what extent the children used stored orthographic representations in spelling these words, and whether the normal and poor readers differed in this respect. The spelling data are inconclusive on this matter.

8 At reading level 1, the analysis of naming times revealed a significant interaction between word type (pseudoword (word) vs. pseudoword (pseudohomophone)) and reader group. The analysis was based on the data of only 10 of the 28 subjects, however.

Our results appear to be at variance with the studies in section 3.1.3, which report that poor readers perform worse than normal readers on tasks measuring orthographic processing skill. The nature of the tasks that were used may be largely responsible for the conflicting results. Stanovich and Siegel (1994) and Foorman et al. (1996) administered a spelling recognition test (Identify the correct spelling of the word: *rain* or *rane*.); Foorman et al. (1996) and Alegria and Mousty (1996) administered a spelling production test. These tasks require explicit knowledge of the spelling of a word and therefore are more likely to detect individual differences in number and quality of orthographic representations than our reading task. Ehri and Saltmarsh (1995) had beginning and poor readers practise reading simplified phonetic spellings of 16 target words (e.g., MESNGR for 'messenger' and THRT for 'thirty'). Three days later the children read originally learned spellings and spellings in which one letter had been altered (e.g., MESNJR and THRTE). The words had two or three syllables (M = 2.2) and their simplified spellings consisted of four, five, or six letters (M = 5.1). Some of the spellings were not orthographically legal. This may have had an unfavourable effect on the acquisition of orthographic representations for the older, poor readers in particular, as they appear to be more sensitive to conventions governing permissible letter sequences. Siegel, Share, and Geva (1995) for instance showed that poor readers were superior to reading-level matched normal readers in recognising the combinations of letters that occur in English words. In the present study the children read real words (e.g., fijn, touw) and orthographically legal pseudowords. The (pseudo)words were monosyllabic and consisted of two or three graphemes (M = 2.7). As the words were less complex, we were less likely to detect individual differences in number, quality or use of orthographic representations. Another explanation for the absence of a reader group effect in the present study may be that Dutch poor readers—in consequence of the regular orthography—find few difficulties in acquiring orthographic representations. This interpretation is supported by Assink et al.'s (1996) results suggesting that Dutch normal and poor readers do not differ in their knowledge of the spelling of words.

We also need to account for the studies in section 3.1.2, which suggest that the orthographic processing skill of poor readers is superior to that of normal readers. Using an auditory rhyme detection task, Rack (1985) and Zecker (1991) found a comparatively large effect of the orthographic similarity of word pairs for poor readers. This can be taken as an indication that poor readers have stored more, or more fully specified orthographic representations, or have better access to them. An alternative interpretation would be that the poor readers have more need to resort to orthographic representations, which, however, may be of equal quality. Holmes and Standish (1996) concluded that their subject KQ was highly proficient at accessing stored orthographic representations, despite poor phonological processing skills. KQ may represent an exceptional case. Moreover, she was considerably older than the poor readers in our study and in the studies reporting inferior orthographic processing skill (section 3.1.3). Consequently, she may have had more opportunity to develop compensatory reading and spelling mechanisms than the younger poor readers in the other studies.

The second question that was addressed in the present study was whether normal and poor readers use phonological representations in reading aloud and whether they do so to the same extent. At each reading level the pseudohomophones (PH) were named more accurately and faster than the pseudowords that had been created from them (PW(ph)). Overall, the interaction between word type (PH vs. PW(ph)) and reader group was not significant. This suggests that the normal and poor readers to the same extent use phonological representations in reading aloud. This appears to be inconsistent with Elbro et al.'s (1996) finding that the phonological representations of poor readers at the beginning of kindergarten were less distinct than those of normal readers. The level of distinctness was measured by a test designed to elicit the child's most distinct pronunciation of single words. The words consisted of three or four syllables, and therefore were much more complex than the words used in our study. The phonological representations of simple monosyllabic words may be equally well specified in poor readers as in normal readers, and may also be equally useful in reading aloud. Another explanation for the absence of a reader group effect in our study may be that the quality of phonological representations does not affect the operation of the lexical (reading) route.

The third and final question was whether *Dutch* poor readers exhibit a pseudoword (= nonword) reading deficit. Overall, we found that the poor readers performed similarly to the normal readers on pseudoword naming. In contrast with Yap and Van der Leij (1993) and Van der Leij and Van Daal (1999), our results do not provide evidence for a pseudoword reading deficit in Dutch poor readers. One might suggest that the reading level match in our study was not adequate. This may be true for the lower reading levels, as we found that at reading level 1 and 2 the words and the corresponding pseudohomophones were named (more accurately and) faster by the poor readers than by the normal readers. It follows that the pseudoword naming skill of the poor readers at these reading levels may be overestimated. However, there are no indications of this at the higher reading levels. Moreover, the reading test used to match normal and poor readers on word recognition skill was similar to the ones used by Yap and Van der Leij (1993) and Van der Leij and

Van Daal (1999). Therefore, the deviant results in our study cannot be attributed to the type of matching test. It is unclear what it can be ascribed to.

In summary, only for the children at reading level 4 we could reliably demonstrate that orthographic representations were used in reading. At each reading level, normal and poor readers were found to behave similarly. A possible explanation for the absence of a reader group effect may be that Dutch poor readers—in consequence of the regular orthography—find few difficulties in acquiring the orthographic representations (of simple words). This needs further investigation. We also found that the normal and poor readers to the same extent use phonological representations in reading aloud simple monosyllabic words. However, this may be different with more complex words. This question needs to be addressed in future research.

4

Acquiring lexical representations through reading or through spelling

In the present study we examined whether the means through which lexical knowledge is acquired—by reading a word repeatedly or by spelling it a number of times—affects the utility of the representation for reading and for spelling. Thirty-four poor readers (23 boys and 11 girls; mean age 9;3 years) received a reading training or a spelling training. Pre- and posttests were used to measure the effect of the training. With regard to reading accuracy, reading practice and spelling practice were found to have different effects. In the reading practice condition accuracy improved more for words practised more often; in the spelling practice condition no differential effect was found of the number of times the words had been practised. This suggested that lexical representations that had been constructed during reading practice were more useful for reading than representations that had been constructed during spelling practice. No differential effect of reading practice and spelling practice on speed of reading practised words was found. Contrary to the accuracy results, the latency results suggested that lexical representations that had been constructed during spelling practice were equally useful for reading as representations that had been constructed during reading practice. Our results therefore were not unequivocal. No differential effect of reading practice and spelling practice on spelling accuracy was found, suggesting that lexical representations that had been constructed during reading practice were equally useful for spelling as representations that had been constructed during spelling practice.

It has been argued that a single orthographic representation is used in both reading and spelling (Coltheart & Funnell, 1987; Friedman & Hadley, 1992). Availability and utility of orthographic representations for reading and spelling, however, may differ because access routes are different and because different demands are made upon the quality of the representations. As Frith (1985) points out, the orthographic representations that children construct from their experience with written language will at first not be precise enough to be useful for spelling, but may be sufficient to be used in recognising written words. Another factor that may affect the utility of the representation is the means through which the word-specific orthographic knowledge is acquired, by reading a word repeatedly or by spelling it a number of times. This issue is addressed in the present study.

Acquiring lexical representations *4.1.1*

In Ehri's (1992) conceptualisation of the acquisition of word-specific orthographic knowledge readers form systematic connections between graphemes seen in the printed word and phonemes detected in the pronunciation of the word. Knowledge of grapheme-phoneme correspondences is used to form these connections. Also, the whole spelling is connected to the whole pronunciation in that the sequence of graphemes corresponds to the sequence of blended phonemes. Analogously, it can be assumed that spellers establish connections between phonemes heard in the spoken word and graphemes used in its spelling and, eventually, between the pronunciation of a word and its spelling. If the direction of the connection affects the utility of the representation for reading, it can be expected that reading practice improves lexical reading skill more than spelling practice. If the direction of the connection has no effect, no differential effect of reading and spelling practice on reading performance is expected.

To our knowledge only one training study reports data relevant to this question. Van Daal and van der Leij (1992) found that words that had been read or spelled repeatedly during training were read correctly more often and were read faster than words that had not been practised. The advantage of practised words over nonpractised words indicated that lexical knowledge was acquired during the training. No differences between practice forms were found. Reading practice and spelling practice improved to the same degree both the accuracy and fluency of reading practised words aloud. This suggested that lexical representations acquired through reading and through spelling were equally available for reading. However, since in the reading practice condition no overt response to the written word (e.g., reading aloud, matching words to pictures, etc.) was required, we cannot be certain that the children actually read the words. In the spelling practice condition a written word was presented and then the child had to copy the word or write the word from memory. Spelling practice thus deviated strongly from the normal spelling process.

Similar expectations can be formulated for spelling as for reading. If the direction of the connection affects the utility of the representation for spelling, it can be expected that spelling practice improves lexical spelling skill more than reading practice. If the direction of the connection has no effect, no differential effect of reading and spelling practice on spelling performance is expected. Several training studies have compared the effectiveness of reading practice and several forms of spelling practice in learning the spelling of words. Bosman and her colleagues (Bosman & de Groot, 1992; Bosman & van Leerdam, 1993; van Leerdam, Bosman, & Van Orden, 1998) had first graders practise words containing an ambiguous phoneme. These words cannot be spelled unequivocally by application of PGC rules; word-specific orthographic knowledge is required. Bosman and her colleagues consistently found that reading is less effective in learning the spelling of words than any of the other practice forms, including copying, (oral) spelling after the target word had been presented visually, and selecting the correct grapheme for an ambiguous phoneme. Not all forms of spelling training were equally effective. Children who had had to write the words from memory made less spelling errors than children who had had to orally spell the words (van Leerdam, Bosman, & Van Orden, 1998); children in the oral spelling condition made less spelling errors than children in the copying condition (Bosman & de Groot, 1992). These results suggest that the utility of the orthographic representation for spelling is affected by the means through which it is acquired. Van Bon and van Staalduinen (1997) had poor spellers practise words containing an ambiguous phoneme. Like Bosman and her colleagues, they found that reading is less effective in learning the spelling of words than copying. Van Daal and van der Leij (1992) had learning-disabled children practise words with complex orthographic structures. They found that less errors were made at posttest in spelling practised words than in spelling words that had not been practised, indicating that lexical knowledge was acquired during the training. The percentage of misspellings dropped from 54 to 40 for words that had been read during training, to 37 for words that had been written from memory, and to 26 for words that had been copied. Reading practice was equally effective in learning the spelling of the words as the form of spelling practice in which words had to be written from memory.

The present study *4.1.2*

The central question in this study is whether the means through which lexical knowledge is acquired—by reading a word repeatedly or by spelling it a number of times—affects the utility of the representation for reading and for spelling. This question is not only theoretically interesting, but also is of practical importance. Should literacy instruction emphasise reading tasks or spelling tasks? Practice form probably influences "how" words are stored in the mental lexicon and consequently lexical reading and spelling skill. In all training studies described above the word to be spelled was presented visually immediately prior to the child's attempt at spelling the word. Normally, the spelling of a word has to be retrieved from long-term memory or generated from its pronunciation. In the present study we wanted to link on more to the normal spelling process. In the spelling practice condition a spoken word was presented to the child, who then had to spell the word by selecting the correct graphemes (from a given set) and putting them in the correct order. The written word was presented—by way of providing feedback—only after the child had spelled the word. As for reading practice, Bosman and her colleagues had the children read words aloud. Most individual reading, however, is silent. Van Daal and van der Leij (1992) had the children read words silently. As was pointed out above, we cannot be certain that the children in their study actually read the words. Van Bon and van Staalduinen (1997) had the children read words silently. Words were isolated, embedded in a sentence, or embedded in a text. A small task is incorporated in the reading exercises. This ensures that chilren read the words. In the present study a written word and three spoken words were presented to the child, who then had to indicate which one of the three alternatives was represented by the written word. Linking visual word forms to auditory word forms is the essence of reading instruction. Reading and spelling practice were implemented on a computer to enable the children to practise without supervisor and still receive intensive feedback.

Two types of words were used: words containing an ambiguous phoneme (/ɛi/ or /ɑu/), which were practised 8 or 4 times, and words containing a consonant cluster (CCVC or CVCC), which were practised 8, 4, or 0 times. In case reading accuracy and speed improved more from pretest to posttest for words practised more often, this would provide evidence that lexical knowledge had been acquired during training and was used for reading. In case spelling accuracy improved more from pretest to posttest for words practised more often, this would provide evidence that lexical knowledge had been acquired during training and was used for spelling. We examined whether the effect of the number of times words had been practised was equally large for children who had practised reading the words and for children who had practised spelling the words. In case the percentage of correct spellings of the ambiguous phoneme increased from pretest to posttest, this would provide evidence that lexical knowledge had been acquired during training and was used for spelling. We examined whether the increase was equally large for children who had practised reading the words and for children who had practised spelling the words.

Method 4.2

Participants 4.2.1

Thirty-four children (23 boys and 11 girls; mean age 9;3 years) who were classified by their teachers as poor readers were selected from three schools for special education. All children were native speakers of Dutch. A standardised reading achievement test, the Three-Minutes-Test (Verhoeven, 1992), was administered to determine the reading level of the participants. Considering the number of months of formal reading and spelling instruction they had had, all children scored in the range of the 10 per cent lowest achieving pupils on this test. The children performed at least one year below age expectancy.

Materials 4.2.2

All words selected for this experiment were familiar in meaning to the children who participated. At least 70 percent of Dutch teachers in kindergarten and first grade consider the words to be familiar in meaning to six-year-old children (Kohnstamm, Schaerlaekens, de Vries, Akkerhuis, & Frooninckxs, 1981). The words probably were not familiar in print to the children, as they are relatively low in frequency. The mean frequency count of the test words is 6 in a corpus of 202,526 printed words from Dutch books and textbooks for children from 7 to 13 years old (Staphorsius, Krom & de Geus, 1988). Appendix E presents the materials used in this experiment.

Words containing an ambiguous phoneme. We selected 24 words containing the ambiguous phoneme /ɛi/, which in Dutch is most often represented by the grapheme ‘ij’. In 16 words /ɛi/ was represented by ‘ij’; in 8 words /ɛi/ was represented by ‘ei’. We selected 15 words containing the ambiguous phoneme /ɑu/, which in Dutch most often is represented by the grapheme ‘ou’. In 10 words /ɑu/ was represented by ‘ou’; in 5 words /ɑu/ was represented by ‘au’. All words were practised during training. The words were of simple orthographic structure (CVC, CV or VC). The words can be read through straightforward application of GPC rules, but cannot be spelled unequivocally.

For each training word, two words were selected that were to be presented as distractors in reading practice. One distractor word contained the same vowel as the training word and different initial and final consonants (e.g., vouw → hout; reis → pijp). The other distractor word contained a vowel which is represented by one of the letters of the digraph representing the vowel of the training word (e.g., vouw → vos) or by a digraph in which the letters are transposed (e.g., reis → riem). The initial consonant was the same.

The set of graphemes the child had to choose from in spelling practice contained the two graphemes that can be used to represent the ambiguous phoneme and the consonant(s) of the training word (e.g., vouw → ou, au, v, w).

Words containing a consonant cluster. We selected 113 CCVC and CVCC words. About half of these words were practised during training. About half of the words that were not practised during training contained a consonant cluster that was practised. We also selected 14 CCVCC words. These words were not practised during training. All words can be read and spelled through straightforward application of GPC rules and PGC rules.

For each training word, two words were selected that were to be presented as distractors in reading practice. Three or four phonemes of the training word—one or both of the consonants of the cluster, the vowel, and the single consonant—correspond to phonemes of the distractor words (e.g., klok → blok, kok; kans → kast, knal).

The set of graphemes the child had to choose from in spelling practice contained the vowel, the three consonants of the training word, and two other consonants (e.g., klok → o, k, l, k, b, r). Each of the additional consonants can make up an orthographically legal cluster with one of the consonants of the target cluster.

In the spelling pre- and posttest words were presented in the context of a sentence, in order to prevent misspellings due to misidentifications of the spoken words. All the words used in these sentence contexts probably were familiar in meaning to the children who participated in this experiment.

Design *4.2.3*

Half of the children received a reading training, and the other half a spelling training. In both conditions, words were practised 8, 4, or 0 times during 16 training sessions (see Table 4.1). Note that the words that are spelled with 'ei' or 'au' were all practised 8 times. To maximise the number of encounters with these graphemes, we chose not to divide the eight words into two frequency categories.

In each session 16 or 17 words containing an ambiguous phoneme and 20 or 21 words containing a consonant cluster were practised. Words were presented in a random order. Words practised eight times were presented once every two sessions; words practised four times were presented once every four sessions.

Table 4.1 Number of words practised 8, 4 or 0 times.

Words containing an ambiguous phoneme

Grapheme	ij [1]	ei	ou [1]	au	Times Practised
	8	8	5	5	8
	8		5		4

Words containing a consonant cluster

Orthographic Structure	CCVC [1]	CVCC [1]	Times Practised
	13	14	8
	13	14	4
	16	16	0 [2]
	12	15	0 [3]

<u>Notes</u>. 1 One set of words was practised 8 times and another set was practised 4 times by 17 of the children. This was reversed for the other 17 children.

2 CCVC / CVCC words containing practised consonant clusters

3 CCVC / CVCC words containing nonpractised consonant clusters

Procedure 4.2.4

The experiment was conducted in a four-month period starting at the end of January. In the first three weeks pretests were carried out. Three weeks later the training started. During eight or nine weeks 16 training sessions were held. In the last three weeks posttests were carried out.

The training comprised 16 sessions. Two sessions were held each week. Both the reading and the spelling training were implemented on a computer. The program enabled the children to practice without supervisor.

In the reading condition each trial started by presenting the word on the computer screen. A row of boxes (1.5 by 1.5 cm) was located at the top of the screen. Each grapheme of the word was placed in a separate box. The word disappeared when the child clicked on *Klaar* [ready]; the word reappeared when the child clicked on *Woord* [word]. The child listened to one, two or all three of the words (the intended word plus two distractor words) by clicking on any of three pictures (a juggler with one, two, or three balls). The child was allowed to look at the word and listen to the words as often as desired, but not simultaneously. The child indicated which one of the three spoken words he or she thought was represented by the printed word by marking the relevant picture. This was done by clicking in a small box beneath it. The position of the intended word was varied. The computer provided feedback by presenting the printed word, stating whether or not the child had made the correct choice, and pronouncing the intended word. The next word was presented when the child clicked on *Verder* [next].

In the spelling condition three rows of six boxes (1.5 by 1.5 cm) were located one below the other on the screen. Each trial started by presenting the set of graphemes the child had to choose from (e.g., v, w, au, and ou for “vouw”; b, k, r, l, k, and o for “klok”). Each grapheme was placed in a separate box in the top row. Correct and incorrect graphemes were presented in random order. The word was dictated by the computer when the child clicked on the picture of a stave. The child was allowed to listen to the word as often as desired. The child spelled the word by selecting the correct graphemes and putting them in the correct order in the middle row. The child could correct any error detected in his own spelling until he clicked on *Klaar* [ready]. The computer provided feedback by stating whether or not the child had spelled the word correctly, pronouncing the word again, and in case the word had been spelled incorrectly by presenting the correct spelling in the bottom row. The next word was presented when the child clicked on *Verder* [next].

The training words and distractor words were read on tape by a female speaker and digitised for presentation on the computer. The children listened to the words through the headphones.

In the reading pre- and posttest the practised and nonpractised words were presented one by one on the screen of an Apple Macintosh Classic II computer. The children were asked to read the words as fast and as accurately as possible. The words were presented in black, lower case letters on a white background in the center of the screen. A letter font used in many educational text books (Helvetica) was chosen. A four-letter word was 2.5 to 3.5 cm wide. The words were 1.0 to 1.5 cm high. Each word was followed by a mask (%#&+). The mask was approximately 4.5 by 1.5 cm. The children were seated approximately 50 cm from the screen and they wore a headset. Naming times were measured by a voice-activated relay connected to the microphone of the headset.

Presentation of each word was preceded by an asterisk (500 ms) in the center of the screen. At the same time an auditory attention signal was given. After 500 ms the word appeared on the screen. Maximum presentation time was 15 s. As soon as the voice-activated relay was triggered by a sound, the word disappeared and the mask appeared where the word was before. The mask was on the screen for 1000 ms. Naming times were measured accurately to the millisecond. By pushing a button on a button box the experimenter registered whether the word was read correctly and whether the clock was stopped by the verbal response of the participant. No feedback was given.

Both the pretest and the posttest were divided into two sessions. The sessions were scheduled on different days. All word types were mixed on presentation. The order of presentation of the words was random. The test was administered individually in a quiet room in the school.

In the spelling pre- and posttest the experimenter read aloud each sentence, and then pronounced the target word separately. The children were then given as much time as they needed to write down the word. They were given the opportunity to correct their spellings when they themselves thought they had made an error.

Both the pretest and the posttest were split into seven sessions, which were scheduled on seven different days. Each session consisted of 23 or 24 words. The words containing an ambiguous phoneme were divided evenly over the sessions, as well as the practised and nonpractised words containing a consonant cluster (CCVC / CVCC / CCVCC). All word types were mixed on presentation. The order of presentation of the words was random and the same for all children. Each session lasted approximately 20 minutes. The test was administered collectively.

Results 4.3

The data of five participants were excluded from the analyses. Records kept during training suggested that four children were poorly motivated to perform the task. Following a series of sessions in which they performed quite well, they appeared to give incorrect responses deliberately. Another child completed only twelve training sessions, because of a technical failure of the apparatus.

Of the remaining 29 participants, 14 took part in the reading condition and 15 took part in the spelling condition. The children in the two conditions were matched for reading ability as measured by the standardised reading achievement test (reading condition: Mean score = 77.14, SD = 34.48; spelling condition: Mean score = 75.73, SD = 35.53; $F < 1$).

We are mainly interested in the effect of the training on reading and spelling skill. Therefore we focus on interaction effects involving the factor test (pretest vs. posttest). In order to improve readability, we only report significant effects ($p < .05$) and marginally significant effects ($p < .10$).

Reading test 4.3.1

Words were practised 8, 4, or 0 times during the training. In case reading accuracy and speed improved more from pretest to posttest for words practised more often, this would provide evidence that lexical knowledge had been acquired during training and was used for reading. We examined whether the effect of the number of times words had been practised was equally large for children who had practised reading the words and for children who had practised spelling the words. We also examined children's reading performance on nonpractised words containing one or two consonant clusters.

Of one child no data were available on the reading posttest. Therefore, the data of one more participant were excluded from the analyses.

CVC words spelled with ij or ou: frequency effect. Recall that the words that are spelled with 'ei' or 'au' were all practised 8 times. Error percentages and median naming times were calculated. Naming times for words that were read incorrectly (7.6%) and times recorded when the clock had not been stopped by the verbal response of the participant, but by another sound (3.0%), were discarded. Median naming times were calculated only if at least 70 % of the relevant observations were valid. As a consequence the data of three more participants were excluded from the analysis of naming times besides the data of six participants excluded at the outset. Table 4.2 presents mean error percentages and means of median naming times of words spelled with 'ij' or 'ou'.

Table 4.2 Mean error percentages and means of median naming times on pretest and posttest of CVC words spelled with 'ij' or 'ou' as a function of practice form and number of times practised (standard deviations in parentheses).

Practice Form	Test	n	Number of times practised: 8		4	
			Error percentages			
Reading	Pre-	13	6.5	(6.2)	11.2	(7.4)
	Post-	13	7.7	(12.6)	5.3	(5.8)
	Effect		- 1.2		5.9	
Spelling	Pre-	15	9.2	(8.8)	9.7	(8.5)
	Post-	15	5.1	(5.6)	5.6	(7.4)
	Effect		4.1		4.1	
			Naming times			
Reading	Pre-	11	1343	(545)	1349	(582)
	Post-	11	1127	(375)	1246	(572)
	Effect		216		103	
Spelling	Pre-	14	1432	(674)	1417	(622)
	Post-	14	1112	(394)	1167	(448)
	Effect		320		250	

A two (test: pretest vs. posttest) by two (practice form: reading vs. spelling) by two (times practised: 8 vs. 4) analysis of variance was performed on subjects' error percentages and on subjects' median naming times. Test and times practised are within-subjects factors. Practice form is a between-subjects factor. The main effect of test was significant in the error analysis ($F(1,26) = 4.83$, $p < .05$) and in the analysis of naming times ($F(1,23) = 16.28$, $p < .01$). Error percentages and naming latency decreased from pretest to posttest, similarly for children in both practice conditions and similarly for words practised 8 times and words practised 4 times.

CCVC / CVCC words: frequency effect. The words that were practised 0 times contained practised consonant clusters. Error percentages and median naming times were calculated. Naming times for words that were read incorrectly (14.8%) and times recorded when the clock had not been stopped by the verbal response of the participant, but by another sound (3.4%), were discarded. Median naming times were calculated only if at least 50% of the relevant observations were valid. As a consequence the data of one more participant were excluded from the analysis of naming times besides the data of six participants excluded at the outset. Table 4.3 presents mean error percentages and means of median naming times of CCVC / CVCC words practised 8, 4, or 0 times during training.

A two (test: pretest vs. posttest) by two (practice form: reading vs. spelling) by three (times practised: 8 vs. 4 vs. 0) analysis of variance was performed on subjects' error percentages and on subjects' median naming times. Test and times practised are within-subjects factors. Practice form is a between-subjects factor.

First, we discuss the results of the analysis of error percentages. The main effect of test was significant ($F(1,26) = 10.91$, $p < .01$), and the interaction between test and times practised approached significance (Wilks' Lambda = .80, $F(2,25) = 3.07$, $p = .06$). Separate analyses were carried out, which revealed that the interaction was significant when comparing words practised 8 times and words practised 4 times ($F(1,26) = 4.46$, $p < .05$), but was not significant when comparing words practised 4 times and words practised 0 times. Error percentages decreased from pretest to posttest, and decreased more for words practised 8 times than for words practised 4 times, but did not decrease more for words practised 4 times than for words practised 0 times.

The interaction between test, times practised, and practice form was significant (Wilks' Lambda = .76, $F(2,25) = 3.95$, $p < .05$). Additional analyses were carried out, which revealed an interaction between test and times practised for subjects in the reading practice condition (Wilks' Lambda = .40; $F(2,11) = 8.18$, $p < .01$), but not for subjects in the spelling practice condition. In the reading practice condition error percentages decreased more for words practised more often; in the spelling practice condition error percentages decreased to the same degree for words practised 8, 4, or 0 times.

Table 4.3 Mean error percentages and means of median naming times on pretest and posttest of CCVC / CVCC words as a function of practice form and number of times practised (standard deviations in parentheses).

Practice Form	Test	n	Number of times practised 8		4		0	
Error percentages								
Reading	Pre-	13	19.4	(9.7)	16.8	(8.5)	18.3	(8.4)
	Post-	13	8.0	(7.2)	12.3	(8.7)	16.1	(7.5)
	Effect		11.4		4.5		2.2	
Spelling	Pre-	15	14.6	(6.3)	13.6	(8.5)	19.4	(9.8)
	Post-	15	11.6	(8.0)	10.1	(7.2)	15.8	(10.0)
	Effect		3.0		3.5		3.6	
Naming times								
Reading	Pre-	12	2241	(841)	2309	(973)	2566	(762)
	Post-	12	1597	(914)	1734	(849)	2186	(1113)
	Effect		644		575		380	
Spelling	Pre-	15	2077	(1123)	2083	(1311)	2045	(1081)
	Post-	15	1732	(899)	1689	(925)	1895	(999)
	Effect		345		394		150	

Next, we discuss the results of the analysis of naming times. The main effect of test was significant ($F(1,25) = 21.44$, $p < .01$), but the interaction between test and times practised was not significant. Separate analyses were carried out, which revealed that the interaction approached significance when comparing words practised 4 times and words practised 0 times ($F(1,25) = 3.62$, $p = .07$), but was not significant when comparing words practised 8 times and words practised 4 times. Naming latency decreased from pretest to posttest, and decreased more for words practised 4 times than for words practised 0 times, but did not decrease more for words practised 8 times than for words practised 4 times. In contrast with the error analysis no differential effect of reading and spelling practice was found.

CCVC / CVCC words: transfer effect. The (nonpractised) words contained either a practised consonant cluster or a nonpractised consonant cluster. Error percentages and median naming times were calculated. Naming times for words that were read incorrectly (17.5%) and times recorded when the clock had not been stopped by the verbal response of the participant, but by another sound (4.1%), were discarded. Median naming times were calculated only if at least 50% of the relevant observations were valid. As a consequence the data of one more participant were excluded from the analysis of naming times besides the data of six participants excluded at the outset. Table 4.4 presents mean error percentages and means of median naming times of nonpractised words.

A two (test: pretest vs. posttest) by two (practice form: reading vs. spelling) by two (consonant cluster: practised vs. nonpractised) analysis of variance was performed on subjects' error percentages and on subjects' median naming times. Test and consonant cluster are within-subjects factors. Practice form is a between-subjects factor. The main effect of test was significant in the analysis of naming times ($F(1,25) = 14.82$, $p < .01$). Naming latency decreased from pretest to posttest, similarly for children in both practice conditions and similarly for words containing practised consonant clusters and words containing nonpractised consonant clusters. Error percentages did not decrease.

CCVCC words: transfer effect. Error percentages and median naming times were calculated for the nonpractised words. Naming times for words that were read incorrectly (16.2%) and times recorded when the clock had not been stopped by the verbal response of the participant, but by another sound (6.9%), were discarded. Median naming times were calculated only if at least 50% of the relevant observations were valid. As a consequence the data of three more participants were excluded from the analysis of naming times besides the data of six participants excluded at the outset. Table 4.4 presents mean error percentages and means of median naming times of nonpractised words.

Table 4.4 Mean error percentages and means of median naming times on pretest and posttest of nonpractised words containing practised or nonpractised consonant clusters (standard deviations in parentheses).

			Word Type						
			CCVC / CVCC Consonant cluster				CCVCC		
Practice Form	Test	n	practised		nonpractised		n		
Error percentages									
Reading	Pre-	13	18.3	(8.4)	16.8	(9.4)	13	14.8	(11.5)
	Post-	13	16.1	(7.5)	14.0	(8.2)	13	18.1	(14.2)
	Effect		2.2		2.8			- 3.3	
Spelling	Pre-	15	19.4	(9.8)	19.0	(7.1)	15	17.1	(15.2)
	Post-	15	15.8	(10.0)	19.8	(12.4)	15	14.8	(16.3)
	Effect		3.6		- 0.8			2.3	
Naming times									
Reading	Pre-	12	2566	(762)	2318	(780)	12	2731	(1082)
	Post-	12	2186	(1113)	2141	(999)	12	2358	(1323)
	Effect		380		177			373	
Spelling	Pre-	15	2045	(1081)	2219	(1125)	13	2470	(1448)
	Post-	15	1895	(999)	1874	(1120)	13	2184	(1178)
	Effect		150		345			286	

A two (test: pretest vs. posttest) by two (practice form: reading vs. spelling) analysis of variance was performed on subjects' error percentages and on subjects' median naming times. Test is a within-subjects factor. Practice form is a between-subjects factor. The main effect of test was significant in the analysis of naming times ($F(1,23) = 4.11$, $p = .05$). Naming latency decreased from pretest to posttest, similarly for children in both practice conditions. Error percentages did not decrease.

Spelling test 4.3.2

Words containing an ambiguous phoneme were practised. In case the percentage of correct spellings of the ambiguous phoneme increased from pretest to posttest, this would provide evidence that word-specific orthographic knowledge had been acquired during training and was used for spelling. We examined whether the increase was equally large for children who had practised spelling the words and for children who had practised reading the words.

CVC, CCVC and CVCC words were practised 8, 4, or 0 times during the training. In case spelling accuracy improved more from pretest to posttest for words practised more often, this would provide evidence that lexical knowledge had been acquired during training and was used for spelling. We examined whether the effect of the number of times words had been practised was equally large for children who had practised spelling the words and for children who had practised reading the words. We also examined children's spelling performance on nonpractised words containing one or two consonant clusters.

Words containing /ɛi/ or /ɑu/. The following analyses involve words that were practised 8 times during the training. The phoneme /ɛi/ was represented by the grapheme 'ij' in 8 words and by the grapheme 'ei' in 8 other words. The phoneme /ɑu/ was represented by the grapheme 'ou' in 5 words and by the grapheme 'au' in 5 other words. Table 4.5 presents mean percentages of correct spellings for each of the ambiguous phonemes. A two (test: pretest vs. posttest) by two (practice form: reading vs. spelling) analysis of variance was performed on subjects' percentages of correct spellings, separately for each phoneme. Test is a within-subjects factor. Practice form is a between-subjects factor. The main effect of test was significant ($F(1,27) = 9.83$, $p < .01$, for the phoneme /ɛi/; $F(1,27) = 19.67$, $p < .001$, for the phoneme /ɑu/). Spelling accuracy improved from pretest to posttest, similarly for children in both practice conditions.

Table 4.5 Mean percentages of phonemes spelled correctly on pretest and posttest as a function of practice form (standard deviations in parentheses).

Practice Form	Test	n	Ambiguous phoneme /ɛi/		/ɑu/	
Reading	Pre-	14	64.7	(15.0)	45.7	(14.0)
	Post-	14	74.6	(12.4)	58.6	(18.3)
	Effect		9.9		12.9	
Spelling	Pre-	15	54.6	(12.2)	50.0	(21.7)
	Post-	15	59.6	(24.6)	63.3	(19.5)
	Effect		5.0		13.3	

CVC words spelled with ij or ou: frequency effect. Recall that the words that are spelled with 'ei' or 'au' were all practised 8 times. Table 4.6 presents mean percentages of words spelled correctly. A two (test: pretest vs. posttest) by two (practice form: reading vs. spelling) by two (times practised: 8 vs. 4) analysis of variance was performed on subjects' percentages of words spelled correctly. Test and times practised are within-subjects factors. Practice form is a between-subjects factor. The main effect of test was significant ($F(1,27) = 17.34$, $p < .01$). Spelling accuracy improved from pretest to posttest, similarly for children in both practice conditions and similarly for words practised 8 times and words practised 4 times.

CCVC / CVCC words: frequency effect. The words that were practised 0 times contained practised consonant clusters. Table 4.7 presents mean percentages of words spelled correctly. A two (test: pretest vs. posttest) by two (practice form: reading vs. spelling) by three (times practised: 8 vs. 4 vs. 0) analysis of variance was performed on subjects' percentages of words spelled correctly. Test and times practised are within-subjects factors. Practice form is a between-subjects factor. The main effect of test and the interaction effects involving the factor test were not significant. Spelling accuracy did not improve for this set of words.

Table 4.6 Mean percentages of words spelled correctly on pretest and posttest of CVC words spelled with ‘ij’ or ‘ou’ as a function of practice form and number of times practised (standard deviations in parentheses).

Practice Form	Test	n	Number of times practised: 8		4	
Reading	Pre-	14	65.2	(13.7)	58.8	(20.1)
	Post-	14	73.6	(15.3)	67.0	(19.2)
	Effect		8.4		8.2	
Spelling	Pre-	15	54.8	(24.5)	54.9	(25.8)
	Post-	15	64.1	(25.0)	65.1	(26.8)
	Effect		9.3		10.2	

Table 4.7 Mean percentages of words spelled correctly on pretest and posttest of CCVC / CVCC words as a function of practice form and number of times practised (standard deviations in parentheses).

Practice Form	Test	n	Number of times practised: 8		4		0	
Reading	Pre-	14	88.6	(8.2)	85.6	(10.4)	88.5	(6.0)
	Post-	14	89.7	(7.4)	85.4	(9.2)	93.7	(4.9)
	Effect		1.1		- 0.2		5.2	
Spelling	Pre-	15	85.6	(12.5)	89.5	(10.3)	89.5	(8.9)
	Post-	15	88.8	(9.4)	89.1	(13.1)	90.6	(9.7)
	Effect		3.2		- 0.4		1.1	

CCVC / CVCC words: transfer effect. The nonpractised words contained either a practised consonant cluster or a nonpractised consonant cluster. Table 4.8 presents mean percentages of nonpractised words spelled correctly. A two (test: pretest vs. posttest) by two (practice form: reading vs. spelling) by two (consonant cluster: practised vs. nonpractised) analysis of variance was performed on subjects' percentages of words spelled correctly. Test and consonant cluster are within-subjects factors. Practice form is a between-subjects factor. The main effect of test ($F(1,27) = 15.66$, $p < .01$) was significant. Spelling accuracy improved from pretest to posttest, similarly for children in both practice conditions and similarly for words containing practised consonant clusters and words containing nonpractised consonant clusters.

Table 4.8 Mean percentages of words spelled correctly on pretest and posttest of nonpractised words containing practised or nonpractised consonant clusters (standard deviations in parentheses).

			Word Type					
			CCVC / CVCC				CCVCC	
			Consonant cluster					
Practice Form	Test	n	practised		nonpractised			
Reading	Pre-	14	88.5	(6.0)	85.4	(8.4)	81.5	(10.0)
	Post-	14	93.7	(4.9)	89.4	(8.2)	88.8	(9.2)
	Effect		5.2		4.0		7.3	
Spelling	Pre-	15	89.5	(8.9)	83.0	(11.7)	81.9	(15.7)
	Post-	15	90.6	(9.7)	88.1	(5.6)	88.6	(9.3)
	Effect		1.1		5.1		6.7	

CCVCC words: transfer effect. Table 4.8 presents mean percentages of nonpractised words spelled correctly. A two (test: pretest vs. posttest) by two (practice form: reading vs. spelling) analysis of variance was performed on subjects' percentages of words spelled correctly. Test is a within-subjects factor. Practice form is a between-subjects factor. The main effect of test was significant ($F(1,27) = 7.74$, $p < .01$). Spelling accuracy improved from pretest to posttest, similarly for children in both practice conditions.

Discussion *4.4*

The central question in this study was whether the means through which lexical knowledge is acquired—by reading a word repeatedly or by spelling it a number of times—affects the utility of the representation for reading and for spelling. We will first discuss the results on the reading test. Are lexical representations that are constructed during spelling practice available for reading and, if so, are they equally useful for reading as representations that are constructed during reading practice?

With regard to *accuracy*, reading practice and spelling practice were found to have different effects. In the reading practice condition accuracy improved more for words practised more often; error percentages decreased more from pretest to posttest for CCVC / CVCC words practised 8 times (11.4%) than for the same type of words practised 4 times (4.5%). In the spelling practice condition no differential effect was found of the number of times the words had been practised on accuracy of reading practised words; error percentages decreased 3.0% and 3.5% on average for CCVC / CVCC words practised 8 times and 4 times respectively. The accuracy results suggest that lexical representations that had been constructed during reading practice were more useful for reading than representations that had been constructed during spelling practice. Error percentages for the CVC words decreased from pretest to posttest, similarly for children in both practice conditions and similarly for words practised 8 times and words practised 4 times. Error percentages for these words—which were of simple orthographic structure—were already very low on the pretest. This may have prohibited differential progress.

Naming *speed* increased more from pretest to posttest for CCVC / CVCC words practised 4 times than for the same type of words practised 0 times, indicating that lexical knowledge was acquired during the training. Practising the words 8 times did not further increase naming speed. This corresponds with the results of Bosman and de Groot (1991), who found that naming speed increased most between the first and second presentation of a word. No differential effect of reading practice and spelling practice on speed of reading practised words was found. Contrary to the accuracy results, the latency results suggest that lexical representations that had been constructed during spelling practice were equally useful for reading as representations that had been constructed during reading practice. Our results therefore are not unequivocal. Bosman (1994, chapter 7) did not find (oral) spelling training to benefit reading. In one experiment beginning readers / spellers were instructed in the spelling of words they had not seen in print before. In another experiment advanced readers / spellers were instructed in the spelling of pseudowords containing at least one ambiguous phoneme. During the spelling training the (pseudo)words were practised orally, and consequently were not encountered in written form. Words that had been practised during training were spelled correctly more often than words that had not been practised. On a naming task, however, the beginning and advanced readers did not seem to profit from the newly acquired spelling knowledge. Words they had learned to spell were not named faster than words they did not know the spelling of. The fact that they were never visually presented with the words may be crucial. In our spelling training the children did see the correct spelling of the words, either produced by themselves or presented by the computer after an incorrect spelling attempt. The effect of spelling training on reading skill may actually be caused by the reading component in spelling. In that case, classroom spelling tasks can be expected to improve lexical reading skill. The contribution of the feedback to children's reading results in the present study is not clear, however. Intensive feedback was given, but the child's role in this was passive. The feedback procedure may have induced reading activity and therefore have diminished differences between the two training conditions. Still, the accuracy results suggest that lexical representations that have been constructed during reading practice are more useful for reading than representations that have been constructed during spelling practice.

Next, we will discuss the results on the <u>spelling</u> test. The question we try to answer is whether lexical representations that are constructed during reading practice are available for spelling and, if so, whether they are equally useful for spelling as representations that are constructed during spelling practice? We found that spelling accuracy for the CVC words improved from pretest to posttest, similarly for children in both practice conditions and similarly for words practised 8 times and words practised 4 times. No effect was found of the number of times words had been practised. This may be interpreted in two ways. The children may have acquired word-specific orthographic knowledge during the training, with the representation being no stronger for words practised 8 times than for words practised 4 times. Alternatively, spelling accuracy may have improved as a result of a stronger preference for the grapheme ‘ij’ in representing the phoneme /ɛi/ and for the grapheme ‘ou’ in representing the phoneme /ɑu/. Two more analyses were performed on the words containing an ambiguous phoneme. These analyses involved equal numbers of words spelled with either homophonous grapheme. The phoneme /ɛi/ was represented by the grapheme ‘ij’ in 8 words and by the grapheme ‘ei’ in 8 other words. The phoneme /ɑu/ was represented by the grapheme ‘ou’ in 5 words and by the grapheme ‘au’ in 5 other words. A changing preference for either of the homophonous graphemes therefore will have no effect on overall spelling accuracy. For example, if a child has no preference for either ‘ij’ or ‘ei’, the phoneme /ɛi/ will be spelled correctly in four of the ‘ij’-words and in four of the ‘ei’-words; if a child has a strong preference for ‘ij’, the phoneme /ɛi/ will be spelled correctly in all of the ‘ij’-words and in none of the ‘ei’-words. The percentage of correct spellings of the ambiguous phoneme increased from pretest to posttest. This provides evidence that word-specific orthographic knowledge had been acquired during the training and was used for spelling. The increase was equally large for children who had practised reading the words and for children who had practised spelling the words. This is in contradiction with the results of Bosman and her colleagues (Bosman & de Groot, 1992; Bosman & van Leerdam, 1993; van Leerdam, Bosman, & Van Orden, 1998), who found that reading was less effective in learning the spelling of words than any of the other practice forms, including copying, (oral) spelling after the target word had been presented visually, and selecting the correct grapheme for an ambiguous phoneme.

Their studies differed from our study in several respects. Children attending first grade in a regular primary school participated. They practised a small number of words (12 or 20) containing an ambiguous phoneme. The words were between 5 and 9 letters long and were highly distinct from each other. Training and testing took place on the same day. In our study children with reading and spelling difficulties attending a school for special education participated. They practised 39 words containing an ambiguous phoneme besides 54 regular CCVC/CVCC words. The words containing one of the ambiguous phonemes /ɛi/ or /ɑu/ were of simple orthographic structure (CVC, CV or VC), but they were much alike (e.g., rijm, rijp, and reis) and therefore could be easily confused. The words were practised 8 times or 4 times in a period of two months. The spelling test was administered one week after the last training session. All of these aspects may have contributed to the “contradictory” results of the studies carried out by Bosman and her colleagues (Bosman & de Groot, 1992; Bosman & van Leerdam, 1993; van Leerdam, Bosman, & Van Orden, 1998) and our study. Our results also appear to contradict with van Bon and van Staalduinen (1997), who found that reading was less effective in learning the spelling of words than copying. Their study differed from our study in two respects: training period and practice form. Training effects may be larger after a shorter, more intensive training period. The specific form of reading practice and spelling practice that is used probably also is an important factor in the success with which children learn the spelling of words.

In a three-week training study with learning-disabled children, van Daal and van der Leij (1992) found that reading was equally effective in learning the spelling of words as writing-from-memory, but less effective than copying. Similar practice forms were used by Bosman and her colleagues, but with different results. Learning ability therefore appears to influence the effectiveness of spelling practice. Further research is needed to clarify the contribution of and interaction between the above-mentioned factors.

Finally, we look at the effect of the training on children's ability to read and spell nonpractised words. On the pretest the children *read* already over eighty per cent of the nonpractised words correctly, but it took them over two seconds to name the words. Accuracy did not improve. Naming speed did improve, similarly for children in both practice conditions and similarly for words containing nonpractised consonant clusters and words containing practised consonant clusters. Since no effect was found of either manipulated factor, it is unclear whether the training affected children's ability to read nonpractised words. Moreover, our training did not require the children to respond quickly. On the pretest the children *spelled* already over eighty per cent of the nonpractised words correctly. Accuracy still improved somewhat, by an average of 3.9 % for the CCVC / CVCC words and by an average of 7.0 % for the CCVCC words. The fact that the children had three more months of literacy instruction probably contributed to their improved reading and spelling performance on nonpractised words.

In summary, our results suggest that lexical representations that have been acquired in one domain can be used in the other. The reading (accuracy) results tentatively suggest that representations that have been constructed during reading practice are more useful for reading than representations that have been constructed during spelling practice. As was pointed out above, the effect of spelling practice on reading skill may be caused by the reading component in spelling. In that case, classroom spelling tasks can be expected to improve lexical reading skill. The spelling results suggest that lexical (orthographic) representations that have been constructed during reading practice are equally useful for spelling as representations that have been constructed during spelling practice. This is in contradiction with the results of other training studies. The specific form of reading practice and spelling practice that is used probably is an important factor in the success with which children learn the spelling of words. Still, we believe that normal classroom reading activity will benefit lexical spelling skill and vice versa.

General Discussion 5

The focus of the present thesis was on the acquisition and use of orthographic representations in Dutch poor readers. As was pointed out in the introduction, phonological processing deficits are less profound for readers of a shallow orthography than for readers of a deep orthography (Seymour, Aro & Erskine, 2003). Consequently, poor phonological skills may be less of an obstacle to the acquisition of orthographic representations in shallow orthographies. Lexical reading and spelling skills may therefore develop differently in a shallow orthography (like Dutch) than in a deep orthography (like English). We aimed at answering three questions: (i) Which of three orthographic difficulties causes most problems for Dutch children learning to spell? (ii) Do normal and poor readers to the same extent use orthographic representations in reading and in spelling? (iii) Do lexical reading skill and lexical spelling skill benefit differently from reading intervention and spelling intervention? In the following sections, we review the results of the studies conducted to answer these questions and compare them with the results of previous studies. We also make some suggestions for future research. In the final section, we discuss a few implications for educational practice.

Difficulties in acquiring Dutch orthography 5.1

In Chapter 2, we examined to what extent children in first and second grade have problems in spelling a number of ambiguous phonemes in familiar words. We found that spelling accuracy was higher for word-initial /s'/ and /f'/ than for /ɛi/ and /ɑu/, which in the majority of cases occupied medial positions. One interpretation is that 's' and 'z' and also 'f' and 'v' are pronounced differently in the dialect of the participants, so that there is a simple one-to-one correspondence between phonemes and graphemes. Another interpretation is that the phonemes /s'/ and /f'/ behave like the phonemes /ɛi/ and /ɑu/ (with spelling variants based on the etymology of words) with the position of the phoneme in the word affecting children's knowledge of their spelling. The role of phoneme position in spelling was given attention by Treiman, Berch, and Weatherston (1993). They showed that initial consonants in nonwords were easier to spell than medial vowels and final consonants in nonwords. Since English vowels typically have more alternative spellings than do consonants, we cannot be sure to what extent children's poor performance on vowels reflects their position or their identity. According to Treiman et al., "position effects may reflect children's phonological analysis abilities, in particular their ability to access various phonemes in nonwords" (p.476). In order to spell real words containing an ambiguous phoneme—as was the case in the present study—children need to access the underlying lexical representations of these words. It is conceivable that position effects carry over into the lexical spelling process. However, it is also possible that the lexical spelling process (available in familiar words) is affected differently by phoneme position than the phonological spelling process (used in nonwords). This needs further investigation.

We also found that spelling accuracy was higher for /ɛi/ and /ɑu/ than for word-final /t/. Recall that the spelling of word-final /t/ can be made audible by pluralizing the word. We concluded that Dutch first and second graders do not use morphological information in spelling. The distinction between etymological and morphological spelling variants in Nunn's (1998) description of Dutch spelling therefore does not appear to have psychological value for beginning spellers. Treiman, Cassar, and Zukowski (1994), on the other hand, showed that English first and second graders do use meaning relations among words (*dirty – dirt*) to aid their spelling. An explanation for the absence of an effect of morphology in the present study may be that it is more difficult for children to produce the inflected form of root words (e.g., /wort/ → /wordə/ in Dutch), than to retrieve the stem of inflected words (e.g., /dɜːdi/ → /dɜːt/ in English). Another explanation may be that the opacity of English orthography forces children to rely more on nonphonological information, whereas the transparancy of Dutch orthography does not encourage children to use other than phonological information. This also needs further investigation.

Another interesting finding was that ambiguous phonemes in words of simple orthographic structure were spelled correctly more often than ambiguous phonemes in words of complex orthographic structure. This was only true for the first graders. As for spelling speed, we found that both first and second graders needed less time to decide which grapheme should be used to represent the ambiguous phoneme in words of simple orthographic structure than in words of complex orthographic structure. These results suggest that the quality or accessibility of orthographic representations is better for simple words than for complex words. However, the effect of orthographic complexity on accuracy and speed of spelling ambiguous phonemes may reflect differences in exposure to specific words. Words of simple orthographic structure probably are encountered more often by beginning readers than words of complex orthographic structure. In the present study, a frequency count was used of printed words in Dutch books and textbooks for children from 7 to 13 years. This may not have been appropriate. For future research purposes it would be helpful if a frequency count were available for smaller age groups.

The orthographic processing skill of normal and poor readers *5.2*

The second question concerned a comparison of normal and deviant reading and spelling development. In Chapter 3 we examined whether poor readers differ from normal, beginning readers in their use of orthographic representations in reading and spelling. We found that high-frequency words were named more accurately and faster than low-frequency words and that words were named more accurately and faster than the corresponding pseudohomophones. These effects were equally large for the poor and normal readers. We concluded that the children used stored orthographic representations in reading aloud, and that the poor and normal readers did so to the same extent.

The poor and normal readers produced equal numbers of phonologically correct spellings of words containing an ambiguous phoneme (/ɛi/ or /ɑu/) and equal proportions of correct spellings. We assumed that the proportion of correct spellings provides a measure of the extent to which the children used orthographic representations in spelling. Upon closer inspection of the word set, we realised that the children may have attained their accuracy levels without referring to stored orthographic representations. Our data therefore are inconclusive with respect to the children's lexical spelling skill. In a study of English-speaking children, Bourassa and Treiman (2003) found that poor and normal readers use word-specific knowledge in spelling real words. Furthermore, the spelling performance of poor readers appeared to be quite similar to that of spelling-level-matched normal readers. This concerned phonological knowledge (i.e., children's ability to symbolise the consonant vowel structure of the items) and orthographic knowledge (i.e., the legality of the letter strings that children used).

The main conclusion of this part of the present study was that the Dutch poor and reading-level-matched normal readers to the same extent use orthographic representations in reading aloud. Several studies of English-speaking children reported that poor readers performed worse than normal readers on tasks measuring orthographic processing skill. The nature of the tasks that were used may be largely responsible for the conflicting results. Spelling recognition and production tests (used by Alegria & Mousty, 1996, Foorman, Francis, Fletcher & Lynn, 1996, Stanovich & Siegel, 1994) require explicit knowledge of the spelling of a word and therefore are more likely to detect individual differences in number and quality of orthographic representations than our reading task.

We also used a spelling task, but our word set led to ambiguous conclusions. It would be worthwhile to repeat our experiment with another set of words. Ehri and Saltmarsh (1995) found that poor readers were at a disadvantage on a lexical reading task. Poor readers and normal beginning readers were taught to read words having simplified phonetic spellings (e.g., MESNGR for 'messenger'). Three days later they read originally learned spellings and spellings in which one letter had been altered (e.g., MESNJR). Original spellings were read faster than some types of altered spellings, indicating that the children were reading the words by lexical access: first graders who were reading at a low level were sensitive to letter alterations in medial as well as initial and final positions of words, whereas the poor readers were sensitive only to initial and final letter alterations. This suggested that the orthographic representations stored by the poor readers were less specified than the representations stored by the younger normal readers. This appears to be in conflict with our conclusion that the Dutch poor and normal readers to the same extent used orthographic representations in reading aloud. There are a number of explanations. Firstly, the original and altered spellings in the study of Ehri and Saltmarsh were more complex than the words and pseudohomophones in our study. Therefore, they were more likely to detect individual differences in number, quality or use of orthographic representations. Secondly, unlike Ehri and Saltmarsh we only examined the global effect of lexicality (words vs. pseudohomophones). Possibly, we will also find subtle differences between poor and normal readers when we look at different phoneme positions. A third explanation for the absence of a reader group effect in our study may be that Dutch poor readers—in consequence of the regular orthography—find few difficulties in acquiring the orthographic representations (of simple words). This is supported by Seymour, Aro, and Erskine (2003) who showed an effect of orthographic depth on normal readers' accuracy and speed of reading familiar words.

The acquisition of lexical representations 5.3

The third question concerned the mode of acquisition of lexical representations. In Chapter 4, we examined whether the means through which lexical knowledge is acquired—by reading a word repeatedly or by spelling it a number of times—affects the utility of the representation for reading and for spelling. Reading practice and spelling practice were implemented on a computer to enable the children to practise independently. Following reading practice, reading accuracy improved more for words that had been practised more often. Following spelling practice, however, no effect was found of practice frequency on reading accuracy. This suggested that lexical representations that had been constructed during reading were more useful for reading than representations that had been constructed during spelling. The latency data did not corroborate this conclusion. Reading speed increased more for words practised more often, to a similar degree for children who had practised reading the words and for children who had practised spelling the words. Our results therefore were not unequivocal. Bosman (1994, chapter 7) did not find spelling training to benefit reading. During the spelling training the (pseudo)words were practised orally, and consequently were not encountered in written form. Words that had been practised during training were spelled correctly more often than words that had not been practised. On a naming task, however, the beginning and advanced readers did not seem to profit from the newly acquired spelling knowledge. Words they had learned to spell were not named faster than words they did not know the spelling of. The fact that they were never visually presented with the words may be crucial. In our spelling training the children did see the correct spelling of the words, either produced by themselves or presented by the computer after an incorrect spelling attempt. We suggested that the effect of spelling training on reading skill may be caused by the reading component in spelling. Furthermore, the feedback procedure in the spelling training may have induced reading activity and therefore have diminished differences between the two training conditions. This problem can be resolved by using a different feedback procedure which encourages children to correct spelling errors.

We also found that accuracy of spelling words containing an ambiguous phoneme improved from pretest to posttest, to a similar degree for children in both practice conditions. We concluded that lexical representations that had been acquired in one domain were used in the other, and that reading practice and spelling practice were approximately equally effective. This is in contradiction with the results of Bosman and her colleagues (Bosman & de Groot, 1992; Bosman & van Leerdam, 1993; van Leerdam, Bosman, & Van Orden, 1998), who found that reading was less effective in learning the spelling of words than any of the other practice forms, including copying, (oral) spelling, and selecting the correct grapheme for an ambiguous phoneme. Their studies differed from our study in several respects. Firstly, age and learning ability of the participants were different. In a training study with learning-disabled children, van Daal and van der Leij (1992) found that reading was equally effective in learning the spelling of words as writing-from-memory, but less effective than copying. Similar practice forms were used by Bosman and her colleagues, but with different results. Learning ability therefore appears to influence the effectiveness of spelling practice. Secondly, the number and type of words that were practised differed. Learners may benefit more from spelling practice in comparison with reading practice when complex words are practised or when the word set is diverse, etcetera. A third difference was that the training period and training-posttest interval in our study were much longer. An advantage of spelling practice over reading practice in learning the spelling of words—as was found by Bosman and her colleagues—may diminish with the lapse of time. Finally, the specific forms of reading practice and spelling practice that were used probably is an important factor in the success with which children learn the spelling of words. It will be interesting to experiment with various practice forms. Further research is needed to clarify the contribution of and interaction between the above-mentioned factors.

Limitations of the present study *5.4*

Like any study, this study has its limitations. First, we must add some critical observations to the spelling tests we used in Chapter 2. In the *written* spelling test the children were required to fill in missing graphemes in word frames (e.g., p__n for "pijn', abriek for "fabriek"). Visual presentation of part of the word may have influenced retrieval of the orthographic representation. Alternatively, the children could be asked to write the graphemes on a blank sheet of paper (e.g., "Write /ɛi/ in the word 'pijn'."). In the *computerised* spelling test pairs of homophonous graphemes were presented prior to the spoken word. The children had to decide as fast and accurately as possible which grapheme should be used in the word in question. By giving the possible answers, the process of retrieving the orthographic representation probably is influenced. At least two alternative (computerised) test procedures could be used. The children could be asked to say the name of the grapheme representing the ambiguous phoneme (e.g., "Say /ɛi/ in the word 'pijn'."). Response times can then be measured by a voice-activated relay. A problematic aspect of this procedure is that 'ij' and 'ei' like 'ou' and 'au' do not have different names. The children could also be asked to write the graphemes on a pressure-sensitive pad. In this procedure the children not only have to decide which grapheme should be used, but also have to produce its spelling. Both processes take up time. Therefore, response time is less informative on the quality of orthographic representations. It would be interesting to repeat the present experiment by using different test procedures.

One factor interfered with a straightforward interpretation of the results in Chapter 2, phoneme position. Future research needs to disentangle the role of phoneme position in the lexical spelling process. To do this the same ambiguous phoneme needs to be presented in different word positions (e.g., *ijs* / *fijn* / *blij* or *eiland* / *keizer* / *karwei*). When more complex words are used, older children will have to participate. We would expect that a position effect is stronger in long words than in short words. It would also be interesting to examine whether the position effect is located in the representation or in the retrieval process? The computerised spelling test could be helpful here. In addition to a spelling test in which the subject is required to respond as quickly as possible (immediate response), a spelling test could be administered in which the subject's response is deferred until some time after the word has been identified (delayed response). When a position effect is found in the 'immediate spelling' test but not in the 'delayed spelling' test, one could argue that the retrieval of the grapheme associated with the ambiguous phoneme in a given word is a position-sensitive process. When a position effect is found both in the 'immediate spelling' test and in the 'delayed spelling' test, one could argue that not all graphemes of a word are represented equally strong in the mental lexicon.

A third limitation of this study concerns the feedback procedures used in the training study described in Chapter 4. The feedback procedure in the spelling training may have induced reading activity and therefore may have diminished differences between the two training conditions. This problem can be resolved by using a different feedback procedure which encourages children to correct spelling errors. For each grapheme position, one could indicate if the correct grapheme is chosen and whether it is placed in the correct position. For example, *GREEN* means 'the grapheme in this position is correct', *YELLOW* means 'this grapheme is not in the correct position', and *RED* means 'this grapheme is incorrect'. This form of feedback would stimulate spelling activity and thus could intensify the differences between spelling training and reading training. A different feedback procedure can also be used in reading practice. In the reading training the children indicated which one of three spoken words they thought was represented by the printed word. When an incorrect choice was made, the computer pronounced the intended word. Instead, the children can be asked to reread the word and make a new choice. The reading training can further be intensified by adding more spoken alternatives. The spelling training can be intensified by increasing the number of graphemes the children have to choose from.

Finally, there are still a lot of obscurities regarding the effect of a number of factors on the acquisition of orthographic representations and the interaction between these factors (age and learning ability of the participants, complexity of the words, diversity of the word set, training period and training-posttest interval, pratice form). Systematic manipulation of these factors will clarify the matter.

Practical implications 5.5

The present study also leads to practical implications. A number of obstacles are known in early spelling education: ‘f’ or ‘v’ at the beginning of a word, ‘s’ or ‘z’ at the beginning of a word, ‘ij’ or ‘ei’, ‘ou’ or ‘au’, and ‘d’ or ‘t’ at the end of a word. Our study shows that first graders and second graders have less difficulty in spelling /f’/- and /s’/- than in spelling /ɛi/ and /ɑu/ (Chapter 2). Learning the spelling of ambiguous phonemes comes down to rote learning, and consequently a lot of repetition. Such spelling drills should focus on words containing /ɛi/ or /ɑu/. The children in our study have even more difficulty in spelling /t/ at the end of a word than in spelling /ɛi/ and /ɑu/ (Chapter 2). This shows that they do not use morphological information in spelling. It seems obvious that the application of a relatively simple rule can prevent many spelling errors. Such rules therefore deserve more attention in early spelling education.

We also found that poor readers performed similarly to reading-level matched normal readers on a number of reading and spelling measures (Chapter 3). Therefore, they appear to use similar processes in reading and spelling simple, familiar words. This suggests that the same instruction methods are appropriate for both poor and normal readers, although the former will need more practice. However, children with reading and spelling problems often develop motivational problems as a consequence of their repeated failure experiences. To enhance motivation, exercises must link on to the developmental level of the child. Assigning tasks that are neither too easy nor too difficult provides opportunities to experience success. Positive feedback also contributes to children’s motivation. Reading and spelling exercises must be made more attractive to children with learning problems by varying the appearance of the exercises. However, this must not divert attention from the words to be studied.

Finally, we found that lexical knowledge that has been acquired in one domain (reading or spelling) can be used in the other (spelling or reading), and that reading practice and spelling practice are equally effective (Chapter 4). We therefore believe that normal classroom reading activity will benefit lexical spelling skill and vice versa. This allows teachers some latitude to vary between reading and spelling activities. It also means that children can be allowed some freedom in choosing between reading and spelling tasks. This may enhance children’s motivation to work at literacy tasks.

References

Alegria, J. & Mousty, P. (1996). The development of spelling procedures in French-speaking, normal and reading-disabled children: Effects of frequency and lexicality. *Journal of Experimental Child Psychology*, 63, 312-338.

Aro, M. & Wimmer, H. (2003). Learning to read: English in comparison to six more regular orthographies. *Applied Psycholinguistics*, 24, 621-635.

Assink, E., Bos, A. A., & Kattenberg, G. (1996). Reading ability and the use of context in orthographic information processing. *The Journal of Genetic Psychology*, 157 (4), 381-396.

Balota, D.A. & Chumbley, J.I. (1985). The locus of word-frequency effects in the pronunciation task: Lexical access and/or production? *Journal of Memory and Language*, 24, 89-106.

Bast, J.W. (1995). *The development of individual differences in reading ability*. Doctoral dissertation. Free University – Amsterdam, The Netherlands.

Bosman, A.M.T. (1994). *Reading and spelling in children and adults: evidence for a single-route model*. Doctoral dissertation. University of Amsterdam, The Netherlands.

Bosman, A.M.T. & de Groot, A.M.B. (1991). De ontwikkeling van woordbeelden bij beginnende lezers en spellers. *Pedagogische Studièn*, 68, 199-215.

Bosman, A.M.T. & de Groot, A.M.B. (1992). Differential effectiveness of reading and non-reading tasks in learning to spell. In F. Satow & B. Gatherer (Eds.), *Literacy without frontiers* (pp. 279-289).

Bosman, A.M.T. & van Leerdam, M. (1993). Aanvankelijk spellen: De dominantie van de verklankende spelwijze en de geringe effectiviteit van lezen als spellinginstructie-methode. *Pedagogische Studièn*, 70, 28-45.

Bourassa, D. & Treiman, R. (2003). Spelling in children with dyslexia: Analyses from the Treiman-Bourassa Early Spelling Test. *Scientific Studies of Reading*, 7 (4), 309-333.

Caravolas, M. (1993). Language-specific influences of phonology and orthography on emergent literacy. In J. Altarriba (Ed.), *Cognition and culture: A cross-cultural approach to psychology* (pp. 177-205).

Coltheart, M., Curtis, B., Atkins, P., & Haller, M. (1993). Models of reading aloud: Dual-route and parallel-distributed-processing approaches. *Psychological Review*, 100 (4), 589-608.

De Graaff, M.B. (1995). *Hemispheric engagement during letter and word identification in beginning readers*. Doctoral dissertation. Free University – Amsterdam, The Netherlands.

Ehri, L.C. (1992). Reconceptualizing the development of sight word reading and its relationship to recoding. In P.B. Gough, L.C. Ehri, & R. Treiman (Eds.), *Reading acquisition* (pp. 107-143). Hillsdale, NJ: Lawrence Erlbaum Associates.

Ehri, L.C. & Saltmarsh, J. (1995). Beginning readers outperform older disabled readers in learning to read words by sight. *Reading and Writing: An Interdisciplinary Journal*, 7, 295-326.

Elbro, C., Borstrom, I., & Petersen, D.K. (1998). Predicting dyslexia from kindergarten: The importance of distinctness of phonological representations of lexical items. *Reading Research Quarterly*, 33 (1), 36-60.

Elbro, C., Nielsen, I., & Petersen, D.K. (1994). Dyslexia in adults: Evidence for deficits in non-word reading and in the phonological representation of lexical items. *Annals of Dyslexia*, 44, 205-226.

Foorman, B.R., Francis, D.J., Fletcher, J.M., & Lynn, A. (1996). Relation of phonological and orthographic processing to early reading: Comparing two approaches to regression-based, reading-level-match designs. *Journal of Educational Psychology*, 88 (4), 639-652.

Friedman, R.B. & Hadley, J.A. (1992). Letter-by-letter surface alexia. *Cognitive Neuropsychology*, 9 (3), 185-208.

Frith, U. (1985). Beneath the surface of developmental dyslexia. In K. Patterson, M. Coltheart, & J. Marshall (Eds.), *Surface dyslexia* (pp. 301-330). London: Erlbaum.

Gillon, G. & Dodd, B. (1994). A prospective study of the relationship between phonological, semantic and syntactic skills and specific reading disability. *Reading and Writing*, 6 (4), 321-345.

Gillon, G. & Dodd, B. (1997). Enhancing the phonological processing skills of children with specific reading disability. *European Journal of Disorders of Communication*, 32 (2), 67-90.

Herdman, C.M., LeFevre, J.-A., & Greenham, S.L. (1994). Implicating the lexicon: Base-word frequency effects in pseudohomophone naming. *Journal of Experimental Psychology: Human Perception and Performance*, 20 (3), 575-590.

Holmes, V.M. & Standish, J.M. (1996). Skilled reading with impaired phonology: A case study. *Cognitive Neuropsychology*, 13 (8), 1207-1222.

Irausquin, R.S. (1997). *Quality and use of phonological representations in poor and normal readers*. Doctoral dissertation. University of Brabant, The Netherlands.

Kerstholt, M.T. (1995). *The phonological skills of blending and segmentation*. Doctoral dissertation. University of Nijmegen, The Netherlands.

Knuijt, P.P.N.A. (2001). *Orthographic knowledge and orthographic skill: a study on reading development.* Doctoral dissertation. University of Utrecht, The Netherlands.

Kohnstamm, G.A., Schaerlaekens, A.M., De Vries, A.K., Akkerhuis, G.W., & Frooninckxs, M. (1981). *Nieuwe streeflijst woordenschat voor 6-jarigen*. Lisse: Swets & Zeitlinger.

Kreiner, D.S. (1992). Reaction time measures of spelling: Testing a two-strategy model of skilled spelling. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 18 (4), 765-776.

Kreiner, D.S. (1996). Effects of word familiarity and phoneme-grapheme polygraphy on oral spelling time and accuracy. *The Psychological Record*, 46, 49-70.

Landerl, K., Frith, U., & Wimmer, H. (1996). Intrusion of orthographic knowledge on phoneme awareness: Strong in normal readers, weak in dyslexic readers. *Applied Psycholinguistics*, 17 (1), 1-14.

Link, K. & Caramazza, A. (1994). Orthographic structure and the spelling process: A comparison of different codes. In G.D.A. Brown & N.C. Ellis (Eds.), *Handbook of spelling: Theory, process and intervention* (pp. 261-294). New York: John Wiley & Sons.

Lukatela, G. & Turvey, M.T. (1993). Similar attentional, frequency, and associative effects for pseudohomophones and words. *Journal of Experimental Psychology: Human Perception and Performance*, 19 (1), 166-178.

McCann, R.S. & Besner, D. (1987). Reading pseudohomophones: Implications for models of pronunciation assembly and the locus of word-frequency effects in naming. *Journal of Experimental Psychology: Human Perception and Performance*, 13 (1), 14-24.

McDougall, S., Hulme, C., Ellis, A., & Monk, A. (1994). Learning to read: The role of short-term memory and phonological skills. *Journal of Experimental Child Psychology*, 58 (1), 112-133.

McRae, K., Jared, D., & Seidenberg, M.S. (1990). On the roles of frequency and lexical access in word naming. *Journal of Memory and Language*, 29, 43-65.

Monsell, S., Doyle, M.C., & Haggard, P.N. (1989). Effects of frequency on visual word recognition tasks: Where are they? *Journal of Experimental Psychology: General*, 118 (1), 43-71.

Nunn, A.M. (1998). *Dutch orthography: a systematic investigation of the spelling of Dutch words.* Doctoral dissertation, University of Nijmegen, The Netherlands.

Paap, K.R., Newsome, S.L., McDonald, J.E., & Schvaneveldt, R.W. (1982). An activation-verification model for letter and word recognition: The word-superiority effect. *Psychological Review*, 89 (5), 573-594.

Paap, K.R., Noel, R.W., & Johansen, L.S. (1992). Dual-route models of print to sound: red herrings and real horses. In R. Frost & L. Katz (Eds.), *Orthography, phonology, morphology, and meaning* (pp. 293-318). Amsterdam: Elsevier.

Rack, J.P. (1985). Orthographic and phonetic coding in developmental dyslexia. *British Journal of Psychology*, 76, 325-340.

Rack, J.P., Snowling, M.J., & Olson, R.K. (1992). The nonword reading deficit in developmental dyslexia: A review. *Reading Research Quarterly*, 27 (1), 28-53.

Reitsma, P. (1983). *Phonemic and graphemic codes in learning to read*. Doctoral dissertation. Free University, Amsterdam.

Savage, G.R., Bradley, D.C., & Forster, K.I. (1990). Word frequency and the pronunciation task: The contribution of articulatory fluency. *Language and Cognitive Processes*, 5 (3), 203-236.

Seidenberg, M.S., Petersen, A., MacDonald, M.C., & Plaut, D.C. (1996). Pseudohomophone effects and models of word recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 22 (1), 48-62.

Seymour, P.H.K., Aro, M., & Erskine, J.M. (2003). Foundation literacy acquisition in European orthographies. *British Journal of Psychology*, 94, 143-174.

Share, D.L. (1995). Phonological recoding and self-teaching: sine qua non of reading acquisition. *Cognition*, 55, 151-218.

Siegel, L.S., Share, D., & Geva, E. (1995). Evidence for superior orthographic skills in dyslexics. *Psychological Science*, 6 (4), 250-254.

Snowling, M.J. (1994). Towards a model of spelling acquisition: The development of some component skills. In G.D.A. Brown & N.C. Ellis (Eds.), *Handbook of spelling: Theory, process and intervention* (pp. 111-128). New York: John Wiley & Sons.

Snowling, M., Wagtendonk, B. & Stafford, C. (1988). Object-naming deficits in developmental dyslexia. *Journal of Research in Reading*, 11, 67-85.

Sprenger-Charolles, L., Cole, P., Lacert, P., & Serniclaes, W. (2000). On subtypes of developmental dyslexia: Evidence from processing time and accuracy scores. *Canadian Journal of Experimental Psychology*, 54 (2), 87-104.

Stanovich, K.E. & Siegel, L.S. (1994). Phenotypic performance profile of children with reading disabilities: A regression-based test of the phonological-core variable-difference model. *Journal of Educational Psychology*, 86 (1), 24-53.

Staphorsius, G., Krom, R.S.H., & de Geus, K. (1988). *Frequenties van woordvormen en letterposities in jeugdlectuur*. Arnhem: CITO.

Swan, D. & Goswami, U. (1997). Phonological awareness deficits in developmental dyslexia and the phonological representations hypothesis. *Journal of experimental child psychology*, 66, 18-41.

Taft, M. & Russell, B. (1992). Pseudohomophone naming and the word frequency effect. *The Quarterly Journal of Experimental Psychology*, 45A (1), 51-71.

Treiman, R., Berch, D., & Weatherston, S. (1993). Children's use of phoneme-grapheme correspondences in spelling: Roles of position and stress. *Journal of Educational Psychology*, 85 (3), 466-477.

Treiman, R., Cassar, M., & Zukowski, A. (1994). What types of linguistic information do children use in spelling? The case of flaps. *Child Development*, 65, 1318-1337.

Van Daal, V.H.P. (1993). *Computer-based reading and spelling practice for young dyslexics*. Doctoral dissertation. Free University – Amsterdam, The Netherlands.

Van Daal, V.H.P. & Van der Leij, A. (1992). Computer-based reading and spelling practice for children with learning disabilities. *Journal of Learning Disabilities*, 25, 186-195.

Van Bon, W.H.J. & Van Staalduinen, I. (1997). Ei of ij, au of ou? Het effect van lees- en schrijfoefening met elkaar vergeleken. *Tijdschrift voor Orthopedagogiek,* 36, 267-274.

Van den Bosch, K. (1991). *Poor readers' decoding skills*. Doctoral dissertation. University of Nijmegen, The Netherlands.

Van den Broeck, W.J.M. (1997). *De rol van fonologische verwerking bij het automatiseren van de leesvaardigheid.* Dissertatie. Rijksuniversiteit Leiden, Nederland.

Van der Leij, A. & Van Daal, V.H.P. (1999). Automatization aspects of dyslexia: Speed limitations in word identification, sensitivity to increasing task demands, and orthographic compensation. *Journal of Learning Disabilities*, 32 (5), 417-428.

Van Ijzendoorn, M.H. & Bus, A.G. (1994). Meta-analytic confirmation of the nonword reading deficit in developmental dyslexia. *Reading Research Quarterly*, 29 (3), 267-275.

Van Leerdam, M., Bosman, A.M.T., & Van Orden, G.C. (1998). The ecology of spelling instruction: Effective training in first grade. In P. Reitsma & L. Verhoeven (Eds.), *Problems and interventions in literacy development* (pp. 307-320). Dordrecht: Kluwer Academic Publishers.

Van Orden, G.C., Pennington, B.F., & Stone, G.O. (1990). Word identification in reading and the promise of subsymbolic psycholinguistics. *Psychological Review*, 97 (4), 488-522.

Verhoeven, L. (1992). *Drie-Minuten-Toets*. Arnhem: CITO.

Wade-Woolley, L. & Siegel, L.S. (1997). The spelling performance of ESL and native speakers of English as a function of reading skill. Reading and Writing, 9 (5-6), 387-406.

Wentink, W.M.J. (1997). *From graphemes to syllables: The development of phonological decoding skills in poor and normal readers*. Doctoral dissertation. University of Nijmegen, The Netherlands.

Wesseling, R.F.J.Q. (1999). *Quality of phonological representations: etioloy and remediation of dyslexia*. Doctoral dissertation. Free University, Amsterdam – The Netherlands.

Yap, R.L. (1993). *Automatic word processing deficits in dyslexia: qualitative differences and specific remediation*. Doctoral dissertation. Free University, Amsterdam – The Netherlands.

Yap, R. & Van der Leij, A. (1993). Word processing in dyslexics: An automatic decoding deficit? *Reading and Writing: An Interdisciplinary Journal*, 5, 261-279.

Zecker, S.G. (1991). The orthographic code: Developmental trends in reading-disabled and normally-achieving children. *Annals of Dyslexia*, 41, 178-192.

Appendix A: Materials used in Chapter 2

Words containing an ambiguous phoneme

/ɛi/	/ɑu/	/f'/	/s'/	/t/
fijn	hout	vijf	zin	dood
vijf	koud	vis	zes	koud
pijn	touw	vuur	zoon	goud
lijn	goud	voet	ziek	lied
rijk	vrouw	vlug	zaal	pad
blij	mevrouw	vlees	zand	geld
vrij	trouwens	vraag	zomer	woord
terwijl	gauw	vrouw	zondag	kwaad
tijdens	blauw	vrij	soort	brood
gelijk	auto	vorm	samen	zand
partij		vriend		mand
opzij		vreemd		vriend
tijger		vandaag		vreemd
reis		veilig		niemand
geit		fijn		geluid
klein		fiets		gebied
trein		feest		honderd
weinig		fles		eiland
meisje		fruit		hout
eiland		fabriek		boot
einde		foto		geit
veilig				pot
paleis				voet
				soort
				kant
				buurt
				feest
				sloot
				fruit
				krant
				sport
				moment
				agent

Appendix A - continued

Pseudowords containing an ambiguous phoneme

/ɛi/	/ɑu/	/f'/	/s'/	/t/
pijk	souw	voes	zoof	guit
rijf	lout	veek	ziep	mit
frijn	glouw	vraal	zunt	foont
slij	prouw	vulk	zert	kriet
kalpij	kroutsel	vlosker	zoegkeen	kirpaat
tijmis	beslouw	vuizig	zanvel	golveut

Appendix B

1				
2				
3				
4				
5				
6	voet	t	L	
7	gelijk	ij	L	
8	vorm	v		R
9	woord	d		R
10	kroutsel	ou		*R*
11	zoon	z	L	
12	mand	d	L	
13	eiland	ei		R
14	foto	f		R
15	sport	t		R
16	koud	ou	L	
17	zunt	z		*R*
18	paleis	ei	L	
19	dood	d		R
20	vlees	v	L	
21	rijk	ij		R
22	zondag	z	L	
23	soort	t		R
24	auto	au	L	
25	voes	v		*R*
26	geit	ei		R
27	fles	f	L	
28	pad	d	L	
29	tijger	ij		R
30	kant	t	L	
31	zaal	z		R
32	kalpij	ij	*L*	
33	vijf	v	L	
34	kwaad	d		R
35	mevrouw	ou		R
36	fruit	t		R
37	pijn	ij	L	
38	vrouw	v		R
39	guit	t	*L*	
40	weinig	ei	L	
41	fijn	f		R
42	vriend	d	L	

Appendix B - continued

43				
44				
45				
46	samen	s		R
47	goud	d	L	
48	vrij	ij	L	
49	vlosker	v	*L*	
50	boot	t		R
51	trouwens	ou	L	
52	vreemd	v		R
53	zes	z	L	
54	feest	t	L	
55	terwijl	ij		R
56	zoof	z		*R*
57	geld	d	L	
58	hout	ou		R
59	fabriek	f	L	
60	veilig	ei		R
61	zand	d		R
62	vis	v	L	
63	blauw	au		R
64				
65				
66				
67	frijn	ij		*R*
68	brood	d	L	
69	lijn	ij	L	
70	zomer	z		R
71	sloot	t	L	
72	partij	ij		R
73	vuur	v		R
74	foont	t	*L*	
75	touw	ou	L	
76	agent	t		R
77	vraag	v	L	
78	einde	ei	L	
79	koud	d		R
80	fiets	f		R
81	souw	ou	*L*	
82	eiland	d	L	
83	voet	v		R
84	klein	ei		R

Appendix B - continued

85				
86				
87				
88	krant	t	L	
89	vandaag	v		R
90	buurt	t		R
91	fijn	ij	L	
92	vraal	v	*L*	
93	vrouw	ou		R
94	niemand	d	L	
95	ziek	z		R
96	meisje	ei		R
97	geit	t		R
98	vriend	v	L	
99	glouw	ou	*L*	
100	vijf	ij		R
101	gebied	d	L	
102	soort	s	L	
103	reis	ei	L	
104	geluid	d		R
105	fruit	f	L	
106	goud	ou		R
107	vrij	v	L	
108	moment	t	L	
109	pijk	ij		*R*
110	zand	z		R
111	opzij	ij	L	
112	lied	d	L	
113	vlug	v		R
114	hout	t		R
115	tijdens	ij	L	
116	zoegkeen	z	*L*	
117	feest	f		R
118	gauw	au	L	
119	vreemd	d		R
120	trein	ei	L	
121	honderd	d		R
122	zin	z	L	
123	kirpaat	t		*R*
124	veilig	v	L	
125	pot	t	L	
126	blij	ij		R

Appendix B - continued

Item type	**Mean position**
simple monosyllabic words	65.66
complex monosyllabic words	66.58
bisyllabic words	66.00
consonant in initial position	67.16
vowel in medial position	65.39
consonant in final position	65.82

Appendix C: Materials used in Chapter 3

Words containing a consonant cluster

High-frequency words		Low-frequency words	
CCVC	CVCC	CCVC	CVCC
plat	kort	plak	bult
trap	dorp	trom	taart
klas	werk	krom	vork
kraan	melk	kraal	wolk
blik	zelf	blok	zalf
broer	half	braaf	golf
fles	hals	fluit	pols
vlug	berg	vlek	kers
slot	want	slok	lint
graag	punt	fris	vent
gras	mens	graf	bons
groot	soms	slak	gans
steen	niets	spek	rits
stem	fiets	steel	muts
stil	vast	stip	gips
stoel	naast	stier	heks
stok	feest	spin	mast
stuk	nest	spook	vest
			hoest
			vuist

Appendix C - continued

(Pseudo)words containing /ɛi/ or /ɑu/

Words	Pseudo-homophones	Pseudo-words[1]	Pseudo-words[2]
geit	gijt	geik	gijk
zijn	zein	zijp	zeip
bij	bei	bijs	beis
mijn	mein	mijg	meig
jij	jei	jijt	jeit
fijn	fein	fij	fei
vijf	veif	vijk	veik
pijn	pein	pijd	peid
rij	rei	rijf	reif
lijn	lein	lijs	leis
tijd	teid	tijn	tein
gauw	gouw	gaup	goup
nou	nau	nous	naus
hout	haut	houk	hauk
jou	jau	joug	jaug
jouw	jauw	jouf	jauf
touw	tauw	toud	taud
kou	kau	koup	kaup
oud	aud	ouf	auf
koud	kaud	koug	kaug
goud	gaud	gouk	gauk

Appendix C - continued

Distractors

Words	Pseudo-homophones	Pseudo-words[1]	Pseudo-words[2]
weg	wech	wag	wach
dag	dach	dig	dich
rug	ruch	reg	rech
goed	goet	geut	geud
bed	bet	buut	buud
dood	doot	det	ded
rood	root	rut	rud
pad	pat	paat	paad
tot	tod	tat	tad
net	ned	nit	nid
kat	kad	ket	ked
wit	wid	wot	wod
pot	pod	peet	peed
zon	son	zen	sen
zee	see	zaa	saa
zes	ses	zoos	soos
ziek	siek	zuik	suik
vol	fol	vool	fool
ver	fer	var	far
vuur	fuur	vor	for
vis	fis	vas	fas

Notes. 1 Pseudowords that have been created from the words
2 Pseudowords that have been created from the pseudohomophones

Appendix D: Correct spellings and all incorrect but phonologically correct spellings of the words

Column A to D present the probabilities of spelling the words correctly in various conditions. A: no preferences; B: strong preference for ‘ij’ and ‘ou’; C: strong preference for ‘ij’ and ‘ou’ and an additional bias to leave out ‘w’ when /ɑu/ is followed by a consonant; D: ... plus knowledge of the morphographemic rule that can be used to decide on ‘t’ or ‘d’ to represent /t/ in word-final position.

Correct	**Incorrect**	**A**	**B**	**C**	**D**
geit	gijt, geid, gijd	1/4	0	0	0
zijn	zein, sijn, sein	1/4	1/2	1/2	1
bij	bei	1/2	1	1	1
mijn	mein	1/2	1	1	1
jij	jei	1/2	1	1	1
fijn	fein, vijn, vein	1/4	1/2	1/2	1/2
vijf	veif, fijf, feif	1/4	1/2	1/2	1/2
pijn	pein	1/2	1	1	1
rij	rei	1/2	1	1	1
lijn	lein	1/2	1	1	1
tijd	teid, tijt, teit	1/4	1/2	1/2	1
gauw	gouw, gau, gou	1/4	0	0	0
nou	nau, nouw, nauw	1/4	1/2	1/2	1/2
hout	haut, houwt, hauwt, houd, haud, houwd, hauwd	1/8	1/4	1/2	1
jou	jau, jouw, jauw	1/4	1/2	1/2	1/2
jouw,	jauw, jou, jau	1/4	1/2	1/2	1/2
touw	tauw, tou, tau	1/4	1/2	1/2	1/2
kou	kau, kouw, kauw	1/4	1/2	1/2	1/2
oud	aud, ouwd, auwd, out, aut, ouwt, auwt	1/8	1/4	1/2	1
koud	kaud, kouwd, kauwd, kout, kaut, kouwt, kauwt	1/8	1/4	1/2	1
goud	gaud, gouwd, gauwd, gout, gaut, gouwt, gauwt	1/8	1/4	1/2	1
mean		.30	.55	.60	.74

Appendix E: Materials used in Chapter 4

Words containing a consonant cluster

practised 8 or 4 times	practised 4 or 8 times	practised 0 times		
		practised consonant cluster	nonpractised consonant cluster	
plak	plas	plof	trom	start
pret	plek	prik	tros	dwerg
klok	prop	klem	kwal	slurf
klus	klap	klep	kwis	klomp
krom	kruk	kras	drop	krent
brok	blok	krul	flap	stomp
vlag	bril	brug	fris	plons
vlek	vlam	slap	graf	grens
slim	slak	slok	grap	spons
knap	slof	vlot	snor	trots
smal	knul	knal	spek	flits
stip	stap	knol	spin	spits
stop	stom	staf		kwast
		stal		stift
		ster		
		stuk		
halt	balk	bult	tulp	
wolk	kurk	dolk	harp	
hark	wolf	vork	fort	
kalf	vals	zalf	hert	
verf	vers	wals	galg	
pols	kalm	kers	wilg	
helm	bont	palm	worm	
lint	vent	munt	pomp	
bons	gans	pont	ramp	
dans	kans	dons	lamp	
muts	rots	wens	rups	
kast	gast	rits	gips	
mast	vest	mest	heks	
post	lift	mist	gesp	
		kist	wesp	
		kaft		

Appendix E - continued

Words containing an ambiguous phoneme

practised 8 or 4 times	practised 4 or 8 times	practised 8 times
fijn	vijf	reis
rij	pijn	geit
lijn	lijf	zeil
pijp	dijk	teil
rijp	wijd	meid
wijn	bijl	eik
lijm	rijm	sein
wijf	vijl	kei
hout	oud	gauw
koud	touw	rauw
fout	goud	lauw
kous	zout	saus
mouw	vouw	pauw

Summary

The focus of the present thesis was on the acquisition and use of orthographic representations in Dutch poor readers. We aimed at answering three questions: (i) Which of three orthographic difficulties causes most problems for Dutch children learning to spell? (ii) Do normal and poor readers to the same extent use orthographic representations in reading and in spelling? (iii) Do lexical reading skill and lexical spelling skill benefit differently from reading intervention and spelling intervention? In the following paragraphs, we review the results of the studies conducted to answer these questions. In the final paragraph, we discuss a few implications for educational practice.

In Chapter 2, we examined to what extent children in first and second grade have problems in spelling a number of ambiguous phonemes in familiar words (word-initial /f'/ represented by 'f' or 'v', word-initial /s'/ represented by 's' or 'z', /ɛi / represented by 'ij' or 'ei', /ɑu / represented by 'ou' or 'au', word-final /t/ represented by 'd' or 't'). In order to spell real words containing an ambiguous phoneme children need to access the underlying lexical representations of these words. We found that spelling accuracy was higher for word-initial /s'/ and /f'/ than for /ɛi/ and /ɑu/, which in the majority of cases occupied medial positions. One interpretation is that 's' and 'z' and also 'f' and 'v' are pronounced differently in the dialect of the participants, so that there is a simple one-to-one correspondence between phonemes and graphemes. Another interpretation is that the phonemes /s'/ and /f'/ behave like the phonemes /ɛi/ and /ɑu/ (with spelling variants based on the etymology of words) with the position of the phoneme in the word affecting children's knowledge of their spelling. It is conceivable that position effects exist in the lexical spelling process.

We also found that spelling accuracy was higher for /ɛi/ and /ɑu/ than for word-final /t/. The spelling of word-final /t/ can be made audible by pluralizing the word. We concluded that Dutch first and second graders do not use morphological information in spelling. The distinction between etymological and morphological spelling variants in Dutch spelling therefore does not appear to have psychological value for beginning spellers. An explanation for the absence of an effect of morphology may be that the children find it difficult to produce the plural form (e.g., /wort/ → /wordə/). Another explanation may be that the transparancy of Dutch orthography does not encourage children to use other than phonological information.

Another interesting finding was that ambiguous phonemes in words of simple orthographic structure were spelled correctly more often than ambiguous phonemes in words of complex orthographic structure. This was only true for the first graders. As for spelling speed, we found that both first and second graders needed less time to decide which grapheme should be used to represent the ambiguous phoneme in words of simple orthographic structure than in words of complex orthographic structure. These results suggest that the quality or accessibility of orthographic representations is better for simple words than for complex words. However, the effect of orthographic complexity on accuracy and speed of spelling ambiguous phonemes may reflect differences in exposure to specific words. Words of simple orthographic structure probably are encountered more often by beginning readers than words of complex orthographic structure.

The second question concerned a comparison of normal and deviant reading and spelling development. In Chapter 3 we examined whether poor readers differ from normal, beginning readers in their use of orthographic representations in reading and spelling. We found that high-frequency words were named more accurately and faster than low-frequency words and that words were named more accurately and faster than the corresponding pseudohomophones. These effects were equally large for the poor and normal readers. We concluded that the children used stored orthographic representations in reading aloud, and that the poor and normal readers did so to the same extent.

The poor and normal readers produced equal numbers of phonologically correct spellings of words containing an ambiguous phoneme (/ɛi/ or /ɑu/) and equal proportions of correct spellings. We assumed that the proportion of correct spellings provides a measure of the extent to which the children used orthographic representations in spelling. Upon closer inspection of the word set, we realised that the children may have attained their accuracy levels without referring to stored orthographic representations. Our data therefore are inconclusive with respect to the children's lexical spelling skill.

The third question concerned the mode of acquisition of lexical representations. In Chapter 4, we examined whether the means through which lexical knowledge is acquired—by reading a word repeatedly or by spelling it a number of times—affects the utility of the representation for reading and for spelling. Reading practice and spelling practice were implemented on a computer to enable the children to practise independently. Following reading practice, reading accuracy improved more for words that had been practised more often. Following spelling practice, however, no effect was found of practice frequency on reading accuracy. This suggested that lexical representations that had been constructed during reading were more useful for reading than representations that had been constructed during spelling. The latency data did not corroborate this conclusion. Reading speed increased more for words practised more often, to a similar degree for children who had practised reading the words and for children who had practised spelling the words. Our results therefore were not unequivocal. The effect of spelling training on reading skill may have been caused by the reading component in spelling. In the spelling training the children saw the correct spelling of the words, either produced by themselves or presented by the computer after an incorrect spelling attempt. The feedback procedure in the spelling training may also have induced reading activity and therefore have diminished differences between the two training conditions. This problem can be resolved by using a different feedback procedure which encourages children to correct spelling errors.

We also found that accuracy of spelling words containing an ambiguous phoneme improved from pretest to posttest, to a similar degree for children in both practice conditions. We concluded that lexical representations that had been acquired in one domain were used in the other, and that reading practice and spelling practice were approximately equally effective. The specific forms of reading practice and spelling practice that were used probably is an important factor in the success with which children learn the spelling of words. A number of other factors may influence the effectiveness of spelling practice: age and learning ability of the participants, the number and type of words that are practised, the training period and training-posttest interval. Further research is needed to clarify the contribution of and interaction between the above-mentioned factors.

The present study also leads to practical implications. A number of obstacles are known in early spelling education: ‘f’ or ‘v’ at the beginning of a word, ‘s’ or ‘z’ at the beginning of a word, ‘ij’ or ‘ei’, ‘ou’ or ‘au’, and ‘d’ or ‘t’ at the end of a word. Our study shows that first graders and second graders have less difficulty in spelling /f’/- and /s’/- than in spelling /ɛi/ and /ɑu/ (Chapter 2). Learning the spelling of ambiguous phonemes comes down to rote learning, and consequently a lot of repetition. Such spelling drills should focus on words containing /ɛi/ or /ɑu/. The children in our study have even more difficulty in spelling /t/ at the end of a word than in spelling /ɛi/ and /ɑu/ (Chapter 2). This shows that they do not use morphological information in spelling. It seems obvious that the application of a relatively simple rule can prevent many spelling errors. Such rules therefore deserve more attention in early spelling education.

We also found that poor readers performed similarly to reading-level matched normal readers on a number of reading and spelling measures (Chapter 3). Therefore, they appear to use similar processes in reading and spelling simple, familiar words. This suggests that the same instruction methods are appropriate for both poor and normal readers, although the former will need more practice.

Finally, we found that lexical knowledge that has been acquired in one domain (reading or spelling) can be used in the other (spelling or reading), and that reading practice and spelling practice are equally effective (Chapter 4). We therefore believe that normal classroom reading activity will benefit lexical spelling skill and vice versa. This allows teachers some latitude to vary between reading and spelling activities. It also means that children can be allowed some freedom in choosing between reading and spelling tasks. This may enhance children's motivation to work at literacy tasks.

Samenvatting

In dit proefschrift richten we ons op de verwerving en het gebruik van orthografische representaties in Nederlandse zwakke lezers. We proberen een antwoord te vinden op de volgende drie vragen: (vraag 1 – hoofdstuk 2) Welke orthografische moeilijkheden veroorzaken de meeste problemen bij Nederlandse kinderen die leren spellen? (vraag 2 – hoofdstuk 3) Maken normale en zwakke lezers in dezelfde mate gebruik van orthografische representaties bij het lezen en spellen? (vraag 3 – hoofdstuk 4) Profiteren de lexicale leesroute en de lexicale spellingroute verschillend van leesinterventie en spellinginterventie? In de onderstaande alinea's geven we een kort overzicht van de resultaten van de studies die uitgevoerd zijn om deze vragen te beantwoorden. In de laatste alinea bespreken we een paar implicaties voor de onderwijspraktijk.

In hoofdstuk 2 onderzochten we in welke mate leerlingen in groep 3 en 4 moeilijkheden ondervinden bij het spellen van ambigue fonemen in bekende woorden (/f'/ aan het begin van een woord welke gespeld kan worden met 'f' of 'v', /s'/ aan het begin van een woord welke gespeld kan worden met 's' of 'z', /ɛi/ welke gespeld kan worden met 'ij' of 'ei', /ɑu/ welke gespeld kan worden met 'ou' of 'au', /t/ aan het einde van een woord welke gespeld kan worden met 'd' of 't'). Om bekende woorden met ambigue fonemen te kunnen spellen moeten kinderen de onderliggende orthografische representaties van deze woorden oproepen. We vonden dat de kinderen minder spelfouten maakten bij /f'/ en /s'/ aan het begin van een woord dan bij /ɛi/ en /ɑu/ midden in een woord. Een mogelijke interpretatie is dat 'f' en 'v' en ook 's' en 'z' een verschillende uitspraak hebben in het dialect van de deelnemende kinderen, zodat er een één-op-één correspondentie bestaat tussen de fonemen en grafemen. Een andere interpretatie is dat de fonemen /f'/ en /s'/ zich gedragen als de fonemen /ɛi/ en /ɑu/ (met spellingvarianten die gebaseerd zijn op de etymologie van de woorden) waarbij de positie van het foneem in het woord medebepalend is voor de kennis van kinderen van de spelling van het foneem in het betreffende woord. De aanwezigheid van positie-effecten in de lexicale spellingroute is niet ondenkbaar.

We vonden ook dat de kinderen minder spelfouten maakten bij /ɛi/ en /ɑu/ dan bij -/t/. De juiste spelling van het foneem /t/ aan het einde van een woord kan achterhaald worden door de meervoudsvorm van het woord te produceren. We concludeerden dat groep-3- en groep-4-leerlingen geen gebruik maken van dergelijke morfologische informatie bij het spellen. Het onderscheid tussen etymologische en morfologische spellingvarianten in de Nederlandse orthografie lijkt geen psychologische waarde te hebben bij beginnende spellers. Mogelijk ondervinden de kinderen te veel moeilijkheden bij het produceren van meervoudsvormen (bijvoorbeeld /wort/ → /wordə/) om van nut te zijn bij het spellen van ambigue fonemen. Een andere verklaring kan zijn dat de transparantie van de Nederlandse orthografie geen stimulans is om naast fonologische informatie andere informatie te gebruiken bij het spellen van woorden met ambigue fonemen.

Een andere interessante bevinding was dat ambigue fonemen in woorden met een eenvoudige orthografische structuur vaker correct gespeld werden door groep-3-leerlingen dan ambigue fonemen in woorden met een complexe orthografische structuur. Zowel groep-3-leerlingen als groep-4-leerlingen hadden minder tijd nodig om het correcte grafeem te kiezen voor het ambigue foneem in woorden met een eenvoudige orthografische structuur dan in woorden met een complexe orthografische structuur. Dit suggereert dat de kwaliteit of toegankelijkheid van orthografische representaties beter is voor eenvoudige woorden dan voor complexe woorden. Echter, dit effect van orthografische complexiteit kan een afspiegeling zijn van de frequentie waarmee deze woorden voorkomen. Beginnende lezers lezen waarschijnlijk vaker woorden met een eenvoudige orthografische structuur dan woorden met een complexe orthografische structuur.

Een vergelijking van de lees- en spellingvaardigheid van normale en zwakke lezers stond centraal in hoofdstuk 3. We onderzochten of zwakke lezers verschillen van normale, beginnende lezers in het gebruik van orthografische representaties bij het lezen en spellen. We vonden dat hoogfrequente woorden accurater en sneller benoemd werden dan laagfrequente woorden en dat woorden (bijvoorbeeld "fijn") accurater en sneller benoemd werden dan de bijbehorende pseudohomofonen (bijvoorbeeld "fein"). Het frequentie-effect en het homofoon-effect waren even groot voor normale en zwakke lezers. We concludeerden dat de leerlingen orthografische representaties gebruikten bij het lezen, en dat normale en zwakke lezers dit in dezelfde mate deden.

De normale en zwakke lezers produceerden gelijke aantallen fonologisch correcte spellingen van woorden met een ambigu foneem (/ɛi/ of /ɑu/) en in verhouding gelijke aantallen correcte spellingen. We veronderstelden dat het aantal correcte spellingen een maat is voor de mate waarin kinderen gebruik maken van orthografische representaties bij het spellen. Nadere beschouwing van het gebruikte woordmateriaal deed ons beseffen dat de leerlingen hun accuratesse-scores behaald konden hebben zonder raadpleging van opgeslagen orthografische representaties. Onze data zijn niet eenduidig met betrekking tot de lexicale spelling route.

In hoofdstuk 4 onderzochten we of de manier waarop lexicale representaties worden verworven—door een woord regelmatig te lezen hetzij regelmatig te spellen—invloed heeft op de bruikbaarheid van de representatie voor lezen en voor spellen. De kinderen kregen lees- of spellingoefening op de computer, zodat ze zelfstandig konden oefenen. Na de leestraining stegen accuratesse-scores op de leestoets meer voor woorden die vaker geoefend waren. Na de spellingtraining vonden we geen effect van oefenfrequentie op de accuratesse-scores op de leestoets. Dit suggereert dat lexicale representaties die verworven zijn tijdens het lezen beter bruikbaar zijn bij het lezen dan representaties die verworven zijn tijdens het spellen. Deze conclusie wordt niet gesteund door de latentietijden. De leessnelheid nam meer toe voor woorden die vaker geoefend waren, in dezelfde mate voor kinderen die leesoefening hadden gehad als voor kinderen die spellingoefening hadden gehad. Onze resultaten zijn dus niet eenduidig. Het effect van spellingoefening op leesvaardigheid kan veroorzaakt zijn door de leescomponent in het spellingproces. Bij de spellingtraining zagen (en lazen) de kinderen de correcte spelling van de woorden, hetzij door henzelf geproduceerd hetzij door de computer na een foutieve spelling. De feedback procedure in de spellingtraining heeft mogelijk ook aangezet tot leesactiviteit en zo de verschillen tussen de twee trainingscondities verminderd. Dit probleem kan worden opgelost door een andere feedback-procedure te gebruiken die kinderen aanmoedigt zelf hun spelfouten te corrigeren.

We vonden ook dat spellingaccuratesse voor woorden met een ambigu foneem toenam van voortoets naar natoets, in dezelfde mate voor kinderen die leesoefening hadden gehad en voor kinderen die spellingoefening hadden gehad. We concludeerden dat lexicale representaties die zijn verworven in het ene domein (lezen) werden gebruikt in het andere domein (spellen), en dat leesoefening en spellingoefening even effectief waren. De specifieke oefenvorm die gebruikt wordt is waarschijnlijk een belangrijke factor in het succes waarmee kinderen de spelling van woorden leren. Een aantal andere factoren beïnvloeden mogelijk de effectiviteit van de spellingtraining: leeftijd en leervaardigheid van de leerlingen, het aantal en soort woorden dat geoefend wordt, de oefenperiode en de tijd tussen training en natoets. Verder onderzoek is nodig om de bijdrage van en interactie tussen deze factoren duidelijk te krijgen.

Het huidige onderzoek leidt ook tot een aantal praktische implicaties. Een aantal knelpunten zijn bekend in het vroege spellingonderwijs: ‘f’ of ‘v’ aan het begin van een woord, ‘s’ of ‘z’ aan het begin van een woord, ‘ij’ of ‘ei’, ‘ou’ of ‘au’, en ‘d’ of ‘t’ aan het einde van een woord. Ons onderzoek laat zien dat leerlingen in groep 3 en 4 minder fouten maken bij het spellen van /f’/ en /s’/ dan bij het spellen van de ambigue fonemen /ɛi/ en

/ɑu/ (hoofdstuk 2). De spelling van ambigue fonemen in specifieke woorden moet uit het hoofd geleerd worden. Dit vergt veel herhaling. Dergelijke inprentingsoefeningen zouden zich moeten richten op woorden met /ɛi/ of /ɑu/. De leerlingen in ons onderzoek maken nog meer fouten bij het spellen van /t/ aan het einde van een woord dan bij het spellen van /ɛi/ en /ɑu/ (hoofdstuk 2). Dit laat zien dat ze geen morfologische informatie gebruiken bij het spellen. De toepassing van een relatief eenvoudige regel zou veel spellingfouten kunnen voorkomen. Dergelijke regels verdienen meer aandacht in het vroege spellingonderwijs.

We vonden ook dat zwakke lezers vergelijkbaar presteren met jongere normale lezers van hetzelfde leesniveau (hoofdstuk 3). De zwakke lezers lijken dus dezelfde processen te gebruiken als jongere normale lezers bij het lezen en spellen van eenvoudige, bekende woorden. Dit suggereert dat dezelfde instructiemethodes geschikt zijn voor zowel normale als zwakke lezers, hoewel de laatsten meer oefening nodig hebben.

Tenslotte vonden we dat lexicale representaties die verworven zijn in het ene domein (lezen of spellen) gebruikt kunnen worden in het andere domein (spellen of lezen), en dat leesoefening en spellingoefening even effectief zijn (hoofdstuk 4). We denken daarom dat leesactiviteiten in de klas een positief effect zullen hebben op de lexicale spellingroute en omgekeerd. Dit geeft leerkrachten enige vrijheid om te variëren tussen lees- en spellingactiviteiten. Het betekent ook dat kinderen enige vrijheid gegeven kan worden bij het kiezen tussen lees- en spellingtaken. Dit kan de motivatie van kinderen vergroten om met dergelijke taken bezig te zijn.

Curriculum Vitae

Monique Coenen is geboren op 1 mei 1969 te Boxmeer. Na de middelbare school studeerde zij Taal- en Literatuurwetenschap met als specialisatie "Tekstwetenschap" aan de Katholieke Universiteit Brabant te Tilburg. In 1993 behaalde zij haar doctoraaldiploma. In datzelfde jaar is zij gestart met het promotieonderzoek dat resulteerde in dit proefschrift. Het onderzoek is uitgevoerd aan de (huidige) Radboud Universiteit bij de sectie Orthopedagogiek. Het onderzoek richtte zich op de verwerving en het gebruik van orthografische representaties bij zwakke lezers. Na afloop van het onderzoeksproject heeft zij enige jaren in deeltijd als juniordocent gewerkt aan de Radboud Universiteit.